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SOCIALLY DISADVANTAGED SUDENTS IN SOCIALLY DISADVANTAGED SCHOOLS: DOUBLE JEOPARDY IN MATHEMATICS ACHIEVEMENT IN THE G8 COUNTRIES

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A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Education in the College of Education at the University of Kentucky

By
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Lexington, Kentucky

Director: Dr. Xin Ma, Professor of Curriculum and Instruction

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Using the G8 countries' (Canada, France, Germany, Italy, Japan, the Russian Federation, the United Kingdom, and the United States) samples from the 2003 Programme for International Student Assessment (PISA), this study aimed to explore the phenomenon of double jeopardy in mathematics achievement for socially disadvantaged students. Double jeopardy is a situation of dual penalties where coming from low socioeconomic status (SES) families and attending low SES schools results in concurrent penalties at both the student level and school level in mathematics achievement.

This study examined the phenomenon of double jeopardy in the G8 countries across four school locations: rural regions, towns, cities, and metropolitan areas. This study also examined four separate definitions of socioeconomic status in order to determine the effectiveness of each definition. The four definitions corresponded to four SES measures utilized in this study: father's SES, mother's SES, family occupation SES, and combined family SES.

Multilevel analysis with students nested within schools indicated that significant double jeopardy effects varied according to SES measure, school location, and country. However, the majority of the double jeopardy effects across all the variables were large in magnitude. Furthermore, the combined family SES and the metropolitan school location were often the most sensitive SES measure and school location, respectively, to double jeopardy in the G8 countries.

KEYWORDS: Double Jeopardy, Hierarchical Linear Modeling,
Socioeconomic Status, School Location,
School Effectiveness

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I would like to dedicate this dissertation to my wonderful parents, Ron and Miki Wilde, for their unfailing support and encouragement throughout all my endeavors. Thank you for giving me the courage and perseverance to pursue my dreams.

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TABLE OF CONTENTS

Appendices

LIST OF TABLES

Chapter 1

Statement of the Problem

Introduction

Over the past fifteen years, the international community has devoted numerous campaigns and efforts to the concept of "Education for All". With the recognition that "all children, all young people and all adults have the human right to benefit from an education that will meet their basic learning needs in the best and fullest sense of the term, an education that includes learning to know, to do, to live together and to be" (United Nations Educational, Scientific, and Cultural Organization [UNESCO], 2000a, p. 8), the international community has directed their collective focus and cooperation to providing and ensuring this education for all. With the acknowledgement that each individual has the right to an education, education has emerged as a keystone for social and economic development in the global community (UNESCO, 2000a; UNESCO, 2000b).

Campaigns to address "Education for All" began with the World Declaration on Education for All in Jomtien in 1990. Throughout the 1990s, subsequent commitments to the importance of education were made at the United Nations Conference on Environment and Development (1992), the World Conference on Human Rights (1993), the World Conference on Special Needs Education: Access and Quality (1994), the World Summit for Social Development (1995), the Mid-Term Meeting of the International Consultative Forum on Education for All (1996), and the Fifth International Conference on Adult Education (1997) (UNESCO, 2000a). However, even with the efforts of these collaborative bodies, the concepts behind them have only been partially realized.

As a result, the international community renewed their focus in 2000 at the World Education Forum, generating *The Dakar Framework for Action*. In this document, the international community consolidated their thoughts, ideas, and concerns about education in the twenty-first century (UNESCO, 2000a). Two of the main goals were (a) to ensure that the "learning needs of all young people and adults are met through equitable access to appropriate learning and life skills programmes," and (b) to improve "all aspects of the quality of education and to ensure excellence of all so that recognized and measurable learning outcomes are achieved by all, especially in literacy, numeracy and essential life skills" (UNESCO, 2000b, p. 1). Moreover, the assembled countries pledged to create inclusive and equitably resourced educational environments conducive to excellence in learning, with clearly defined levels of achievement for all; they also pledged to monitor any progress towards these goals and strategies at various levels, including at national and international levels (UNESCO, 2000a).

While *The Dakar Framework for Action* specifies literacy and numeracy as areas of concern, various countries have also been concerned with the broader subjects of reading, science, and mathematics. Throughout the educational research of the past five decades, the importance of all three subject areas has been noted. According to the Cologne Charter, "the challenge every country faces is how to become a learning society and to ensure that its citizens are equipped with the knowledge, skills and qualifications they will need in the next century" (G8 Information Centre, 1999, p. 1). This is especially important, since societies and economies are based more and more on knowledge and information. In particular, one result of social and economic developments has been the greater prominence of mathematics in today's global society. For this reason, mathematics achievement (or mathematical literacy) has become an even more necessary component of an equitable and quality education.

Many research studies have examined mathematics in relation to socioeconomic status (SES), a factor considered both influential and consistent in its effect on equitable education. Specifically, comparisons in achievement between socially disadvantaged students and their more advantaged peers have illustrated a long-standing pattern of achievement gaps between such students. In particular, studies have shown a widespread socioeconomic impact on mathematics outcomes (Brown, 1991; Chall, 1996; Crane, 1996; Papanastasiou, 2000). In the past five years, researchers have continued to note the same pattern of differentiation by SES level on mathematics achievement: low-SES students perform worse than high-SES students (Abedi & Lord, 2001; Cox, 2000; D'Agostino, 2000; Opdenakker & Van Damme, 2001; Papanastasiou, 2000; Smees, Sammons, Thomas, & Mortimore, 2005; Webster & Fisher; 2000). In addition, Howie and Pietersen (2001) noted SES disparities in mathematics achievement at the school level, with students from schools in disadvantaged areas attaining lower scores than students from schools in advantaged areas. These outcomes alone have been enough to warrant the extra measures and pledges related to the "Education for All" campaign.

The extensive nature of the "Education for All" campaign exceeds the scope and ability for this study, which limits its focus to the study of SES in mathematics achievement to the G8 countries: Canada, France, Germany, Italy, Japan, the Russian Federation, the United Kingdom, and the United States. The decision to limit the study in this manner is based on (a) the importance of mathematics as a critical filter for increasingly technological and scientific occupations, and (b) the slow progress being made in providing equity in education as regards to socially disadvantaged students. On the other hand, the choice of the G8 countries for the analysis has a basis in the following considerations: international influence, economic similarities, and similarities within their education systems.

International Influence

As stated above, the G8 countries are influential in both promoting and informing international policies and commitments. For example, the annual G8 Summit provides direction for the international community by setting priorities, defining new issues, and giving guidance to established international organizations (G8 Information Centre, 2005). While most of the influence appears strongly related to social and economic developmental issues, education has been increasingly identified as a major factor in achieving the aims in these domains.

Before the international community turned their attention to the state of education in the 1990s with the "Education for All" campaign, the G8 Summits had already initiated discussions about education, albeit in a limited context, in the 1980s. After 1984, education had been consistently mentioned in the Summit Communiques, accompanied by phrases such as "training to improve occupational skills" (p. 3) and "improving education and training" (p. 4) (Kirton & Sunderland, 2005). By the 1990s, the role of education gained prominence, as world leaders and other ministers from the G8 began to equate education with “programs that invest in human capital” (Kirton & Sunderland, 2005, p. 6).

According to Kirton and Sunderland (2005), by the 1990s, the G8 had greatly expanded their view of education, and they felt the need to “increase investment in [the] people: through better basic education; through improving skills… and through developing a culture of lifetime learning” (p. 6). In fact, the G8 considered basic education, vocational training, academic qualification, and lifelong upgrading of skills “essential [in] shap[ing] economic and technical progress as we move towards a knowledge-based society” (p. 9). In order to achieve these goals, the G8 recognized the need for both the Organization for Economic Cooperation and Development (OECD) and the United Nations Educational, Scientific and Cultural Organization (UNESCO) to study student achievement as it relates to raising standards in the different countries (Kirton & Sunderland, 2005). Internationally recognized tests were seen as building blocks, raising educational standards by providing benchmarks for student achievement.

The G8 investment in the state of education became increasingly clear at the Cologne Summit of 1999. According to the Cologne Charter, “the challenge every country faces is how to become a learning society and to ensure that its citizens are equipped with the knowledge, skills and qualifications they will need in the next century” (G8 Information Centre, 1999, p. 1). One of the main principles espoused was that special attention should be given to the needs of the disadvantaged, and that education should enable all children to achieve in reading, writing, and arithmetic.

Only a year later, the G8 Education Ministers met in Tokyo shortly before the World Education Forum in Dakar (G8 Information Centre, 2000). In this meeting, education was discussed as the base or foundation for the development of the individual as a constructive member of the society, as well as the base for the development of social and economic concerns. However, the education ministers noted that the opportunities created by education are not shared equally throughout the society, and that socially disadvantaged students (economics and home background), students limited by educational opportunity, and students limited by low expectations are often left behind. After *The Dakar Framework for Action* (2000), the G8 continued to support the goals and strategies developed for the “Education for All” campaign. However, they also expanded upon their own previous references to education by discussing measures for disadvantaged children (including students from rural areas), and the need for not only primary education, but for children to complete school (Kirton & Sunderland, 2005).

In order to address many of the fundamental issues concerning education, the G8 governments are continuously pursuing aims which include (i) raising student performance, (ii) developing indicators that monitor and compare educational performance and practices, and (iii) counteracting the disadvantages of poverty and social neglect (G8 Information Centre, 2000). Furthermore, G8 officials emphasize the importance of utilizing existing international organizations and databases, such as OECD, to review the progress of education.

In 2006, educational issues continued to garner more attention and importance than in the past. As a focus of the 2006 G8 Summit, the aims and strategies previously raised remained central to the current discussions of the state of education. In addition, the discussions also expanded upon the “Education for All” agenda, as well as the need for higher standards and better preparation in mathematics (G8 Information Center, 2006).

Similarities between Countries

The undeniable leadership of the G8, similarities between the educational systems of the G8 countries, and the importance of mathematics as a critical filter make the comparisons of educational outcomes (especially mathematics) an important component of educational reform and improvement, especially with regards to the education of socially disadvantaged students. Like the international influence of the G8 countries, the similarities in the education systems have been studied and well documented. These similarities include the progression of schooling, the separation in schooling according to curriculum, and the age at which mandatory schooling ends.

For all eight countries, the progression of schooling follows a hierarchy in the education system. More specifically, students progress from pre-primary school to primary school, to lower-secondary school, to upper-secondary school, and finally to postsecondary school (Sen, Partelow, Miller & Owen, 2005). While the division of education by curriculum is not as unanimous as the progression of schooling, most of the countries do have the tendency to separate a student’s course of study by curriculum. In Germany, the separation into general, enhanced, integrated, and academic programs begins around the age of 10, at the beginning of lower-secondary school. For France, Italy, the Russian Federation, and the United Kingdom, the separation of curriculums (into typically academic and vocational programs) does not begin until the students reach a minimum of 15 years of age, usually during the final years of upper-secondary school

(Sen et al., 2005). In contrast, three countries do not officially divide schools into separate curriculums: Canada, Japan, and the United States.

A final similarity in the education systems of the G8 countries is the age for the end of mandatory education. Even though this age differs by country, it ranges from 15 years old to 17 years of age (Sen et al., 2005). Japan, Italy, and the Russian Federation end mandatory education at 15, while France, Canada, the United Kingdom, and the United States require attendance until the age of 16. Germany alone requires students to attend school until the age of 17. Despite the differences, the range of ages is not great enough to be detrimental in comparative studies; thus, with the similarities in the educational system and in the ages for the end of compulsory education, research concerning educational attainment and generalizations through the international comparison of the G8 countries should evaluate students up to the age of 15, concerning their knowledge of "universal" subjects such as reading, science, and mathematics.

Summary

The best way to gain an understanding of a trend in research is to limit the differences or confounding variables in a study. However, because educational studies involve a social component with inherent complications, limiting any potentially confounding variables can be difficult. For this reason, the initial design of the study utilizes countries with the similarities discussed above; thus, providing a more solid foundation to begin the examination of the impact of socioeconomic status on mathematics achievement. By analyzing the data from the G8 countries, this study tries to gain more insight into how the underlying mechanisms or interactions within education systems affect achievement among socially disadvantaged students. Specifically, this study aims to redefine the mechanism of how socioeconomic status affects mathematics achievement by considering, in conjunction with one another, both the student-level and school-level SES.

Purpose of the Study

Research at both the school and student levels has indicated that socioeconomic status significantly affects academic achievement, especially in mathematics. However, few researchers have directed their energies to a simultaneous study of SES at both levels. Even fewer have incorporated a differential effectiveness study of school location into research.

Most of the existing studies incorporating concurrent analysis of both student-level SES and the school-level SES primarily focus on issues other than double jeopardy, which ascertains whether or not dual penalties occur at both the student level and school level (Ma, 2005). As such, the studies typically do not discuss the results in relation to this concept. This oversight appears to be the result of the state of current and past research literature. Over the past forty years, researchers have been unable to clarify some issues centering on SES, such as (a) the effect of a higher school SES on achievement, (b) the SES level that should be addressed through policies, (c) the steps that need to be taken in order to solve the social and educational implications of SES in schools, and (d) the inability of the international community to adequately address and lessen the impact of SES in mathematics education. As a result, further clarification of these older issues, through established research designs and questions, seems to take precedence over new and potentially insightful ways of considering the impact of SES on academic achievement.

This study will strive to address some of these issues by providing a new lens through which to consider the impact of SES on mathematics achievement: the double jeopardy phenomenon. Hopefully, this new approach will offer some clarification as to why past studies and changes in policy have not yielded the increases in mathematics achievement anticipated for socially disadvantaged students.

In order to address the above concerns, data from the Programme for International Student Assessment (PISA) was utilized for this study. PISA is an international study of reading, mathematical, and scientific literacy of students at the end of compulsory education. Because the 2003 cycle focuses on mathematical literacy, its data was chosen. Even though forty-one countries participated in the assessments, this study only employed the data from the G8 countries: Canada, France, Germany, Italy, Japan, the Russian Federation, the United Kingdom, and the United States (see Organisation for Economic Co-operation and Development [OECD], 2005b). Data on student performance was collected via assessment test, while information on social, cultural, and educational factors was collected through student and student representative (administrator) questionnaires.

The primary aims of this current study are (a) to establish whether or not a phenomenon of double jeopardy of SES occurs in the G8 countries, (b) to identify the SES measures that are most likely to substantially affect double jeopardy (conditional upon school location), (c) to identify which school locations significantly influence double jeopardy, and (d) to determine whether or not generalizations of the double jeopardy phenomenon can be made, based on the eight countries included in the analysis.

Aside from SES, many factors have been known to influence mathematics achievement, including student-background characteristics and school-context or composition variables. As such, this study utilizes variables from these categories as controls during the examination of the double jeopardy phenomenon. The addition of control variables to the study allows for a more refined investigation of double jeopardy in mathematics achievement. Consequently, the specific questions addressed in this study will also be more relevant to the educational literature. For example, does the double jeopardy phenomenon appear to manifest more in cities or in metropolitan areas? Is double jeopardy evident for all of the SES measures in the town location in the United States? Do the G8 countries exhibit a similar pattern with regards to double jeopardy in rural areas?

The PISA 2003 data is appropriate for the primary intentions of this study, as well as for the more explicit questions. Specifically, this data provides a basis for comparison of student performance on general knowledge and skills in mathematics, as determined by its role in the real world. Also, by sampling students at the age of 15, PISA provides a more reliable means of determining the "yield" of a student's knowledge and skills at a time when the student can choose to become a full participant and contributor in society.

Definition of Terms

In the literature, *Double Jeopardy* refers to a situation of dual penalties, at both the student level and the school level (Ma, 2005). However, because of the limited research on dual penalties, the use of double jeopardy has been limited, essentially only to a few studies in the last five years. In terms of socially disadvantaged students, statistically, double jeopardy refers to the concurrent significance of SES at both the student and school levels (Ma & Dundas, 2009). In short, the dual penalties (low SES at both the home and the school) work against the learning of disadvantaged students. As regards to this study, double jeopardy is considered solely within the context of the student's mathematics achievement.

Socioeconomic Status (SES) refers to the measure of an individual or family's relative economic and social position (or rank) in a hierarchical society, based on factors such as income, education, wealth, and prestige (National Center for Education Statistics [NCES], 2006; Krieger, 2001). In many studies, SES is represented by either a composite indicator of parents' education, parents' occupation, and family income, or a proxy measure, such as a student's eligibility to receive free or reduced lunches (see Abedi & Lord, 2001; Duncan, 1961; Hughes, 2003; White, 1982). Unlike previous studies, PISA 2003 provides four SES measures: one for each parent and two for family SES.

In the PISA 2003 study, the first three SES measures used are actually derived from the highest occupational status of each parent, as coded in accordance with the International Standard Classification of Occupations (ISCO, 1990); these are then mapped to the international socio-economic index of occupational status (ISEI) (OECD, 2005b). This provides one measure for the father's SES and one for the mother's SES. The first family SES measure (family occupation SES) combines the SES information for both the father and mother. However, only the higher of the two ISEI scores, or the only score if there is only one parent, is incorporated in this measure. In contrast, the second family SES measure (combined family SES) reflects the typical components of SES in the literature: education, occupational status, and income. Specifically, this index of economic, social, and cultural status is derived from the highest level of parental education, highest parental occupation (family occupation SES), and the number of home possessions. All four SES measures are included in this study.

While *School Location* typically refers to the location of the school in terms of the urbanicity or ruralness of the community and also the placement within the community (Reynolds, 1991), researchers utilize numerous definitions for school location based on one or more of the following: population density, economic activity, size of place (i.e., village or city), geographic dispersion, or culture of the residents (Webster & Fisher, 2000; Winters, 2003). For PISA, school location is based on the population size of the community in which the school is located. From PISA's 2003 school questionnaire, five options are provided: (i) village, hamlet or rural areas (less than 3,000), (ii) small town (3,000 to about 15,000), (iii) town (15,000 to about 100,000), (iv) city (100,000 to about 1,000,000), and (v) big city or metropolitan area (over 1,000,000) (OECD, 2005a). However, for this study, the "rural areas" and the "small town" categories are combined to form one single "rural" school location, accounting for the populations ranging from 1 to 15,000.

The term rural in this case is an arbitrary term, used only to describe this population and not necessarily in reference to the typical rural definition used in previous studies. Even with this slight adjustment to the above categories, school location as defined by the population size is less ambiguous than those based on terms such as "rural" and "urban", which have various meanings and definitions.

Mathematics Achievement refers to "the amount of mathematical skills and knowledge that an individual knows" and is able to demonstrate (Secada, 1992 as cited in Ma, 1997). In the context of PISA, mathematics achievement indicates the level of mathematical literacy attained by the student at the end of compulsory schooling (OECD, 2005b):

> Mathematical literacy is an individual's capacity to identify and understand the role that mathematics plays in the world, to make well-founded mathematical judgments and to engage in mathematics, in ways that meet the needs of the individual's current and future life as a constructive, concerned, and reflective citizen. (as defined in *PISA 2003 Assessment Framework- Mathematics, Reading, Science and Problem Solving Knowledge and Skills, OECD, 2003*).

PISA has designed the mathematics achievement test to assess three dimensions of the definition of mathematical literacy: the content or structure, the range of processes, and the situation or context. Instead of focusing on the ability to perform specified operations, the emphasis is on the ability to pose and solve mathematical problems (see Appendix A for example questions).

In order to assess the student's mathematical literacy, PISA achievement tests measure four content categories, representing the "big ideas" or overarching concepts of mathematics: (a) space and shape, (b) quantity, (c) change and relationships, and (d) uncertainty. By processes, PISA refers to the set of general mathematical processes or competencies needed in all levels of education. Use of mathematical language, modeling, problem-solving, mathematical thinking and reasoning, mathematical argumentation, mathematical communication, and representation are some of the general processes pertinent at all education levels. Thus, these are some of the processes included in the assessment. Finally, PISA utilizes five situations or contexts within the framework: personal, educational, occupational, public, and scientific. These three dimensions of mathematical literacy (content, process, and context) are then evaluated according to three "competency clusters": reproductions, connections, and reflections (OECD, 2005b).

The methodology utilized in this study is known as "hierarchical linear modeling" or HLM. Hierarchical linear modeling is a statistical technique that uses multiple levels to model the data. Because educational studies inherently represent a hierarchical structure of students nested within schools, multilevel modeling is the most appropriate method for analysis. As such, HLM was the technique chosen to study the phenomenon of double jeopardy on mathematics achievement. For this study, the hierarchy consists of the students in the schools; therefore, the model has two levels: the student designated as the level-one unit, and the school designated as the level-two unit. According to Raudenbush and Bryk (2002), this analysis allows for the study of relationships at one level, without ignoring the variability associated with the other level in the data hierarchy.

Criteria for Variable Selection

As in any research study, several different types of criteria are used for variable selection: the specific criteria designated for the type of research, the research questions, and any potentially confounding variables. In order to address the first criteria, the type of research must be identified. While this study focuses on how and if SES affects mathematics achievement simultaneously at two levels, it essentially examines the type of schools (in relation to SES) that are the most effective for mathematics achievement. Therefore, this study falls under the school effectiveness paradigm and attempts to identify the variables and configuration of variables that make some schools (and students) more effective than others (Goldstein, 1997). As such, a main objective is to separate the relative influence of home from that of the school on academic achievement (Wrigley, 2004). Thus, the variables selected for this study should reflect the criteria related to this type of research. According to Opdenakker, Van Damme, De Fraine, Van Landeghem, & Onghena (2002), in order to create a model of an effective school, factors from both the school level (contextual, compositional, and process and instructional variables) and the student level need to be taken into account.

By combining both student and school-level variables, the mechanisms of effectiveness associated with how significant factors interrelate with different schools in academic achievement may be identified (Mortimore, Sammons, Stoll, Lewis, & Ecob, 1989). In the process, the analysis can also determine the influence of those variables that are adjustable (those that can be altered through changes in policy) and those deemed unalterable (Creemers & Scheerens, 1994).

At the school level, both contextual and compositional school variables often fall into the category of variables that cannot be altered. In contrast, characteristics designated as school-process or instructional variables are often considered malleable. Corresponding variables at the student level reflect the same associations. For example, student-background variables, such as gender and family structure, are unchangeable, while the amount of homework is not. Because of the limited nature of previous research on the double jeopardy phenomenon, this study has been designed to provide a foundation for future research. As such, the variables selected reflect only those dimensions with unchangeable variables: student-background variables, school-contextual variables, and school-compositional variables.

The second criterion for the variable selection is the research questions. Because research questions are identified and justified through the examination of previous research, the principle variables suggested by this research provide clues for the study. To study the effect of double jeopardy on mathematics achievement, in relation to socioeconomic status, a focus on SES at both the student and school levels is necessary. In addition, incorporation of both the student-level and school-level SES meets some of the criteria for a school effectiveness study, by separating the influence of the home and school.

Because SES is a student-background characteristic at the student level, and a school-composition variable at the school level, this study on double jeopardy initially meets the above criteria. Moreover, the focus on SES illustrates a well-documented connection between SES and achievement. For instance, in 1982, White concluded that the relationship between student achievement and SES is one of the most constant research findings in the past half century. Also, according to the literature, the consistency in the findings occurs when SES is measured at both the student level and the school level. Specifically, studies show a trend of socially disadvantaged students scoring lower than their peers from advantaged homes (Abedi & Lord, 2001; Brown, 1991; Cox, 2000; D’Agostino, 2000; Opdenakker & Van Damme, 2001; Papanastasiou, 2000; Smees et al., 2005; Webster & Fisher; 2000). In addition, Smees et al. found school SES to influence student achievement over and above individual characteristics, including student-level or family-level SES.

As the literature demonstrates, the importance of including a socioeconomic variable at both the student and school levels is well justified. However, the inclusion of not one, but four SES measures at each level is not based on the generalized conclusions of the effect of SES, but rather on the examination of specific factors comprising SES measures. Because the factors used to measure SES often depend on the data available and the perspective of the researcher, a wide range and combination of different factors have been utilized: parents' education, parents' occupation, parents' income, educational and literacy resources in the home, and occupational prestige (see D'Agostino, 2000; Duncan, 1961; Lubienski, 2002; White, 1982). As a result, the SES measures are very diverse. Thus, for this study, the division of the SES measures into father's SES, mother's SES, and two family SES measures provides more clarity for an otherwise extensive variable.

Aside from SES, this study has also selected variables consistent with the first two criteria, which also reflect the need to address potentially confounding variables. As stated above, these variables are limited to student-background characteristics and school- compositional variables, which potentially have the greatest effect on the double jeopardy phenomenon. Thus, variables such as race/ethnicity, gender, immigration background, home language, and family structure fit into the study design. However, they are utilized primarily as control variables. Unfortunately, because this study employs an existing database, PISA 2003, which does not incorporate a race/ethnicity variable, it is not included in this study.

School location, school size, school type, proportion of girls, student-to-mathematics teacher ratio, proportion of mathematics teachers, and proportion of mathematics teachers with a degree in mathematics are the school variables included in this study. The majority of these variables are also treated as control variables; however, because school location has a prominent role in this study, it is incorporated not as a variable but through differential effectiveness analysis. As such, this type of design may be able to account for the influence of school location, while primarily focusing on the effects of double jeopardy.

As discussed above, the variables of focus in this study, SES and school location, fit the criteria for school effectiveness research. However, because of the limited nature of the study, the designated control variables do not address all of the dimensions specified for a complete model of school effectiveness (i.e., process and instructional variables). Nevertheless, the design reflects the primary purpose of the study: to expand our understanding of how SES affects mathematics achievement.

Research Questions

This study considers the phenomenon of double jeopardy as it relates to socioeconomic status in mathematics achievement at the end of compulsory education in the G8 countries. It also examines the effect in terms of various definitions of SES and school location, as measured in the PISA 2003 study. As such, the design of this study reflects two assumptions: (a) regional differences exist with regard to double jeopardy, and (b) differential double jeopardy effects on mathematics achievement also exist for different SES measures.

The main research questions are:

1. What is the absolute effect of the double jeopardy phenomenon for different SES measures (father's SES, mother's SES, family occupation SES, and combined family SES) for each of the four school locations (rural region, town, city, and metropolitan area) in the G8 countries?
2. How would the absolute effect of the double jeopardy phenomenon change once both the student-level variables (gender, immigration background, home language, and family structure) and school-level variables (school size, proportion of girls, school type, student to mathematics teacher ratio, proportion of mathematics teachers, and proportion of mathematics teachers with a degree in mathematics) are controlled in the analysis?
3. What comparisons between the G8 countries can be made from the above double jeopardy results?

Methodological Concerns

The primary methodological concern related to this study centers on mathematics achievement, as defined in comparative studies. Previous comparative studies, such as the Trends in International Mathematics and Science Study (TIMSS) and the National Assessment of Educational Progress, have revolved around the need to assess mathematics achievement as it relates to curriculum (NCES, 2004). For example, TIMSS incorporates the intended curriculum (the mathematics that society intends for students to learn and the education system that the society believes is best designed to facilitate such learning), the implemented curriculum (what is actually taught, who teaches it, and how it is taught), and the achieved curriculum (what students have learned and their attitudes towards mathematics) (*TIMSS assessment frameworks and specifications 2003)*. However, assessments based on the curricula of an international, or even national community, are limited by common curricular elements.

For this reason, another definition for mathematics achievement may address this methodological limitation of comparative studies, which essentially restricts the types of mathematics assessed. Unlike these studies, PISA assessments do not concentrate on mathematics achievement in terms of mastery of the school curriculum, but rather in terms of important knowledge and skills needed in adult life (NCES, 2004). By utilizing literacy instead of the typical definition of achievement, PISA draws on both school curriculum and on any learning that may occur outside of school. However, the focus remains on the "yield" of education, or how mathematics is used in the real-world context. Because mathematics used in the real world is remarkably similar throughout the international community, there is less restriction for what can be included in the assessment. As such, analysis of the PISA data will provide a better foundation for the study of the double jeopardy phenomenon than data from the TIMSS and NAEP studies.

Another important methodological concern related to the design of this study on double jeopardy is the multitude of definitions that have been used to measure SES. These definitions often include combinations of parental education, parental occupation, income, and resources at the home (Abedi & Lord, 2001; Hughes, 2003; White, 1982). Unfortunately, much of the previous research on SES has not identified or stressed these differences, primarily because the results have been so consistent. However, this study will address this concern by incorporating four different measures of SES.

Justification for the Study

For nearly forty years, socioeconomic status has been acknowledged as influencing student achievement in academic arenas. This has especially been true of mathematics achievement; however, even though researchers and policy-makers recognize the significance of SES on achievement, there has been little success in changing the status quo. This enduring effect underscores the belief that our understanding of these social characteristics is perhaps not sufficient enough to allow for improvements in academic achievement. Consideration of SES in a new light, as a type of double jeopardy, might allow researchers (1) to better understand the mechanisms underlying the influence of SES, and (2) allow them to address these challenges in a more comprehensive and meaningful manner. This study contributes to a better understanding of the effect of SES on mathematics achievement by expanding upon earlier studies, while addressing some of the limitations.

Since the 1960s, numerous studies have shown a relationship between SES and mathematics achievement. For example, Mortimore et al. (1989) concluded that differences in circumstances between the advantaged and disadvantaged can substantially impact academic achievement. Bruce Biddle (1997) also found that poverty, reinforced by poor funding in disadvantaged school districts, was responsible for the majority of the low achievement in the United States (as cited in Wrigley, 2004). At both the student and school levels, SES shows a fairly consistent effect on mathematics achievement. Yet, because these studies typically focus on either the family SES or the school SES, not both, they are limited in scope and application.

Only a limited amount of research examines both family SES and school SES. Of that small portion of the research literature, few studies actually consider both levels of SES simultaneously in the analysis. Unlike the hundreds of studies utilizing only one type of SES, only Goddard, Tschannen-Moran, and Hoy, (2001), Kohr, Master, Coldiron, Blust, and Skiffington (1989), Ma and Dundas (2009), and Yang (2003) analyzed the effect of SES on mathematics achievement by incorporating both family SES and school SES in the same model. As such, it is evident that research on the simultaneous examination of SES, at both the student and school levels, has been largely overlooked in the forty years that SES has been a component of educational research. Furthermore, the results have varied. While most of the results indicate that both variables remain significant when evaluated in this manner (Yang, 2003; Kohr et al., 1989), Goddard et al. (2001) could not conclude that school SES remained significant. Also, Ma and Dundas (2009) found that the concurrent significance of both levels of SES depended on (a) the type of SES, and (b) the school location. Thus, further research is needed to adequately understand such results.

Another limitation of the previous research on SES is the multitude of definitions that have been used to measure this variable. These definitions often include combinations of parental education, parental occupation, income, and resources at the home. Also, the proxy measure, eligibility of students to receive free or reduced lunches, has played a frequent role in many studies. Because many of the definitions contain the same elements, the results primarily indicate a consistency in the effect of SES on mathematics achievement. Consequently, this limitation has not been sufficiently addressed in previous research. Only Ma and Dundas (2009) incorporate multiple definitions or measures for SES in their research.

Based on the two limitations discussed above, the study by Ma and Dundas (2009) appears to best address these gaps in the research. This study analyzed the PISA 2000 mathematics data simultaneously, for both the student-level and school-level SES. Specifically, the double jeopardy phenomenon was examined for three SES measures (father's SES, mother's SES, and family SES) in four school locations (rural region, town, city, and big city) in the United States. The results indicated that double jeopardy exists and is significant in the United States for both the father's SES and the family's SES in the rural region, the town, and the city; none was found for the mother's SES or for the big city school location.

With these results, Ma and Dundas (2009) established a foundation for the study of double jeopardy in mathematics achievement. However, more research in this area needs to be done. Primarily, future research on this topic should employ data emphasizing mathematics achievement, unlike the PISA 2000 data, which focused not on mathematics but on reading. In addition, further research is needed in order to (i) provide either support for or against the double jeopardy results found in the previous study, (ii) establish that the result is more general and applies not only to more countries but also to other data sets, and (iii) include other critical variables that may potentially lessen the impact or magnitude of the double jeopardy effect.

This current study attempts to expand on this research by addressing each of the above objectives. Specifically, this study will examine the double jeopardy phenomenon for the G8 countries in relation to four SES measures and four school locations, utilizing the 2003 PISA mathematics data. In addition, unlike Ma and Dundas (2009), this study will incorporate student-background variables, school-contextual variables, and school-compositional variables as control in the double jeopardy models.

Limitations of the Study

One of the primary concerns or limitations of this study is the difference between the definition of SES in this study and that in the existing literature. Since the 1960s, SES has been defined by researchers in numerous ways; however, the typical operalization of SES in the literature has been as a composite indicator of both parents' education, both parents' occupation, and the family income when available (see Duncan, 1961; White, 1982). As previously described, three of the SES measures for this study are defined and coded based on the parent's occupation. While these PISA definitions do not include education and family income, the coding into an international index provides a general meaning for the SES indicators. However, because there are some differences among the definitions, the extent that the effects of the double jeopardy phenomenon may or may not show consistency with future findings from other definitions is not readily available. Fortunately, the fourth SES measure included in this study is based more on the traditional elements of education, occupation, and income. As such, this measure might be able to span the gap.

Another potential limitation of the study is the grouping of schools into four school locations. With the potentially diverse definitions of what constitutes a rural area, town, city, metropolitan area, or even other categories, it is difficult to determine if the findings would be consistent or comparable in studies that tend to define such areas differently. Fortunately, this study, by using the same categories as Ma and Dundas (2009), will have at least one study for comparison. Other problems with this division by school location are the questions of remoteness of the area, the type of economy, and other cultural influences. These issues should be attended to in future research.

While this study includes numerous control variables, two important variables are excluded from the study: race/ethnicity and prior achievement. Even though both variables are important to measuring academic achievement, PISA 2003 does not include either category in the data collection. Unfortunately, this is a limitation that could indicate a greater effect of the double jeopardy phenomenon, as both are significant variables in their own right. Nevertheless, this disadvantage is acceptable, given the comparative nature of this international study, and given that the need to utilize this data set was more compelling than the need to include these variables. However, this limitation should also be addressed in future studies.

Organization of the Study

Four chapters comprise the remainder of this study. Chapter 2 reflects the research literature and establishes a context for the treatment of both double jeopardy and school location in this study. Chapter 3 presents the methodology of this study, while the statistical analysis and the results are presented in Chapter 4. Finally, Chapter 5 provides a synopsis of the research findings, a discussion of the implications for further educational policy, and any recommendations for future research. Following Chapter 5 are the References and the Appendices.

Chapter 2

Review of Literature

The purpose of this study is to investigate the differences in mathematics achievement attributable to the double jeopardy of socioeconomic status (SES) among students in the G8 countries, while also taking into account the differences associated with school location. Beyond this primary purpose, this study also considers the impact of these differences in order to assess practical implications for mathematics education. Chapter 2 consists of three sections: (a) Contextual Framework, (b) Literature Review, and (c) Summary. In the first section, the Contextual Framework provides the justification for the current research. Section Two summarizes previous research on family SES, school SES, school location, and the combination of these variables for mathematics achievement. In addition, this section also considers previous research on the impact of these variables on mathematics achievement. The final section of this chapter reiterates previous research findings and identifies any questions not adequately addressed by research that support this proposed study.

Contextual Framework

Since the 1960s, one of the most relevant and necessary foci for educational research has been the quest for equity. According to Wenglinsky (1998), equity refers to a situation in which students' educational outcomes are affected as little as possible by characteristics (e.g., socioeconomic background and urbanicity) previously determined to put the students at a disadvantage.

Two of the earliest and most influential studies examining equity in schools are the Coleman Report from 1966 and the findings from the Plowden Committee in 1967. The publication of *Equality of Educational Opportunity*, a report headed by James S. Coleman, concluded that a student's academic achievement was more related to the social composition of the school, the student's family background, and the student's sense of control of the environment and the future, as opposed to the quality of the school (Kiviat, 2005):

> Schools bring little influence to bear on a child's achievement that is independent of his background and general social context… this very lack of an independent effect means that the inequality imposed on children by their home, neighborhood and peer environment are carried along to become the inequalities with which they confront adult life at the end of school. For equality of educational opportunity must imply a strong effect of schools that is independent of the child's immediate social environment, and that strong independence is not present in American schools (Coleman et al., 1966, p. 325).

These findings, concerning American schools, were reflected in the United Kingdom through the 1967 findings of the Plowden Committee (Slee & Weiner, 2001). According to the document, educational performance of each child varied with the degree of support and encouragement provided by the parents, which was inextricably linked to social, economic, and cultural factors of the student's background (Plowden Report, 1967).

With these conclusions, researchers became aware of the inequities facing students in schools. In the decades since the Coleman Report and the Plowden Committee, a consciousness of the inequities in education has become integral to governments and educators across the world. Moreover, there has been a movement to eliminate or reduce these inequities, specifically in subject areas like reading, mathematics, and science. This awakening has led to international agreements and internal reforms in the hopes that a quality and equitable education will be available for students of all backgrounds, ages, and nationalities.

In particular, for mathematics, the need for a quality and equitable education has become integral for the success of students in society. As a result of technological innovations and widespread use of mathematics, a greater emphasis has been placed on increasing students' understanding, achievement, and use of mathematics. According to the NCTM (2000), mathematics competency opens doors for students, providing them with additional opportunities to go to college, get better jobs, and earn more money. However, the lack of mathematics knowledge or proficiency potentially impacts the economical survival of individuals and families for decades to come (Ma, 1999). In fact, mathematics has become known as a "critical filter" for students precisely because an inadequate mathematics preparation may cause students to lose many career choices available to them (Sells, 1973 as cited in Ma, 1999 p. 3). Above all, it is this increasing dependency on mathematics that underscores the necessity for individuals of different backgrounds to receive an equitable mathematics education.

School Effectiveness Paradigm

One of the primary methods that researchers use to investigate equity in education, especially in mathematics, is the analysis of achievement through the school effectiveness paradigm. According to the Coleman Report (1966), "equality of educational opportunity must imply a strong effect of schools that is independent of the child's immediate social environment…" (p. 325). Thus, the examination of schools for this effect reflects the basic tenets of an equitable education. School effectiveness research attempts to separate the relative influence of home from that of the school on academic achievement (Wrigley, 2004). Specifically, this paradigm focuses on exploring differences both within and between schools, in an attempt to identify the variables or configuration of variables that make some schools more effective than others (Goldstein, 1997). In the process, the analysis can also determine the influence of those variables that are malleable or adjustable and those deemed unchangeable (Creemers & Scheerens, 1994). As a result, research with this purpose must address the following question: "how does one decide which of the numerous possible factors has a significant bearing on a school's effectiveness?" (Wrigley, 2004, p. 233).

In order to answer this question, the specific variables significant to school effectiveness must be identified. In the early stages of school effectiveness research, Edmonds (1979) determined five factors to be significant: educational leadership, emphasis on teaching basic skills, high expectations, orderly and safe climate, and frequent evaluation (Creemers & Scheerens, 1994; Lezotte, 1989). Subsequent research has augmented this list of factors; however, the research has also indicated that the relevance of some of the original five factors has not been substantiated with empirical evidence. Current research now shows a multitude of factors that need to be considered in school effectiveness research, both from the student level (student-intake characteristics) and the school level (context, process, and instructional variables).

Student-Intake Characteristics

Student-background characteristics have been recognized as essential components of academic achievement since the Coleman Report and the Plowden Committee released their findings. Background factors such as gender, race, initial achievement, achievement motivation, aptitude, immunity to stress, and language spoken at home have been associated with school effectiveness (Creemers & Scheerens, 1994; Opdenakker & Van Damme, 2001; Opdenakker et. al., 2002). Furthermore, for the past four decades, the most consistently identified student-intake characteristic cited for its relevancy towards school effectiveness research has been the student's socioeconomic status (SES) (White, 1982).

While all the subsequent research supports the importance of student-background variables, Lezotte (1989) concluded that the validity of Coleman's theory remains primarily intact. And, even though the literature appears to place more emphasis on one or two background variables, such as SES or initial achievement (Bosker & Scheerens, 1989; Scheerens, Bosker & Creemers, 2000), Mortimore et al. (1989) maintains that it is crucial for studies of school effectiveness to include more intake characteristics for a better understanding of the impact on mathematics achievement and the subsequent differences between schools.

Unfortunately, the overwhelming abundance of student-background variables requires researchers to limit the number of factors included in each study. As a result of this limitation, researchers utilize previous literature and school effectiveness models to determine which intake characteristics should be included in each study. For example, Mortimore et al. (1989) included age, class, sex, race, language background, and family circumstance in their study, while Scheerens and Bosker (1997) found that the four characteristics of ability, sex, race, and SES could be more appropriate choices for explaining mathematics achievement (as cited in Opdenakker & Van Damme, 2001).

School-Context Variables

As an extension of the student-intake characteristics discussed in the previous section, variables at the school level, classified as school-context and school-composition variables, are also important for school effectiveness research. In addition, these variables, which describe background characteristics at the school level, often appear alongside student-intake variables into the category of variables that cannot be altered. As such, these variables have been studied for years for their effect on academic achievement, and in many cases, research has shown these variables to be influential.

Researchers have defined the term “context” in two ways: (a) as the type of school, and (b) as the student-body composition (Firestone & Herriot, 1982; Stoel & Scheerens, 1988; Wimpelberg, Teddlie, & Springfield, 1987) (as cited in Scheerens, Vermeulen & Pelgrum, 1989). These definitions are further classified under distinct designations. According to Creemers and Scheerens (1994), context variables are the socioeconomic and educational conditions of schools, including both the guidelines and regulations of the schools and the characteristics of the formal structure of the education system (i.e., mean SES, degree of urbanization). On the other hand, compositional variables refer primarily to those illustrating the distribution of the school’s population (i.e., proportion of female students, ratio of students to teachers). Many times, the school level “context” variables employed in the research are aggregates of the student-level data. For example, some of the most common variables of these types include mean initial cognitive ability, mean SES, and the proportion of girls in the school (Opdenakker et al., 2002).

As a result of the similarities to the student-intake variables, researchers have also stressed the necessity for such variables to be incorporated into the research (Fraser, 1989; Mortimore et al, 1989). Some of the most commonly examined variables for their effect on academic achievement are mean SES, mean initial ability, proportion of girls, the degree of urbanization of the school, and the proportion of minorities (Mortimore et al., 1989; Rutter & Maughan, 2002; Scheerens, Vermeulen & Pelgrum, 1989). Of these variables, one of the most influential to a student's academic achievement is mean SES (Muijs and Reynolds, 2003; Winters, 2003). However, unlike the student-level variables (i.e., SES), the corresponding school-level variables (i.e., mean SES) often display more ambiguity and less consistency in the results.

Process and Instructional Variables

Because researchers no longer ascribe to the belief that schools cannot compensate for society (Opdenakker & Van Damme, 2001), school effectiveness research has expanded its focus by attempting to discern factors of effective education that could be introduced, discarded, or altered through the process of school improvement. Consequently, a multitude of new factors, which primarily fall under the categories of school-process and school-instructional variables (including school climate variables), have been found to influence student achievement. Also, according to Opdenakker et al. (2002), these variables appear to be more extensive.

According to D'Agostino (2000), school-process variables describe the organization, climate, and culture of the school. For example, process variables include the focus on discipline and subject-matter acquisition, attention to student differences and development, leadership, orderly learning environment, parental involvement, expectations of the students, and teaching-staff cooperation in relation to teaching methods and student counseling (Opdenakker et al., 2002; Scheerens & Bosker, 1997).

In contrast, school-instructional variables are considered to be those factors that specify school and classroom activities (D'Agostino, 2000). Specifically, variables such as the total time spent on homework, the use of published tests, the use of teacher-made tests, effective learning time, structured teaching, and opportunity to learn are instructional characteristics (Opdenakker et al., 2002; Scheerens & Bosker, 1997).

Unlike student-background variables and school-context variables, school-process and instructional variables are considered malleable to the research community. For this reason, the introduction of these factors in school effectiveness research reflects the view that schools can balance out, or at least lessen, the effects of society and family. Consequently, these variables should be included alongside school-context and student-background variables in any school effectiveness model.

General Conclusions

According to Opdenakker et al. (2002), in order to create a model of an effective school, all of the above dimensions must be taken into account. As such, the majority of the research on effective schools focuses on a combination of student- and school-level factors, in an attempt to discern the mechanisms of effectiveness associated with how significant factors interrelate to differentiate schools in terms of academic achievement (Mortimore et al, 1989). For example, the London studies of school effectiveness from the 1970s, examined gender, race, initial achievement, SES, and age in conjunction with school-level variables, including teacher involvement, structured lessons, work-centered environment, communication between teachers and students, parental involvement, climate, class size, peer influences, level of resources, mean SES, mean initial ability, proportion of girls, and the degree of urbanization of the school (Mortimore et al., 1989; Rutter & Maughan, 2002; Scheerens, Vermeulen & Pelgrum, 1989).

Even though the combination of variables incorporated into any given study differs based on the intent and the research literature, some conclusions appear to be, if not universal, then fairly generalizable, and have been accepted in the school effectiveness paradigm. First, findings indicate that student achievement and behavior can be influenced by characteristics of the school environment (Rutter & Maughan, 2002). Second, many studies indicate that most of the variation in achievement is due to individual student characteristics; however, both classes and school also play an important role (especially for mathematics achievement) (Opdenakker et al., 2002). Third, in order to improve student achievement, and thus school effectiveness, researchers need to simultaneously maximize several different factors with relationships to achievement (Fraser, 1989). Finally, none of the factors, no matter how consistently their effect, guarantee success, but rather provide a set of guidelines for the study of school effectiveness based on empirical evidence (Mortimore et al., 1989).

Researchers utilizing this multi-dimensional design have expanded upon these general conclusions for the guidelines. Specifically, researchers have concluded that not all student-level variables have the same significance, nor does that significance translate between academic subjects, such as reading and mathematics (Mortimore et al, 1989; Opdenakker & Van Damme, 2001). Also, some studies indicate that while student-background and school-composition variables weaken the effects of school-process variables, the school-process variables do remain relevant to school effectiveness research (Opdenakker & Van Damme, 2001). Furthermore, Fraser (1989) found that, in a synthesis of 134 school effectiveness studies, the greatest relationships with achievement were with the student's prior achievement, intellectual ability, and disposition to learn. A major implication of the synthesis, that incidentally mirrors the conclusions drawn from previous studies, was that "no single factor alone has an enormous impact on student learning" (p. 707, Fraser, 1989)

Scheerens and Bosker (1997) best sum up the results of school effectiveness studies through the 1990s. In a meta-analysis of findings from over 150 studies, including some from Europe, North America, and Australia, Scheerens and Bosker found that the results at the school level for variance explained in achievement differ markedly, depending on whether or not the research took into consideration student-intake characteristics (Rutter & Maughan, 2002). The school-based variations accounted for 19% of variance in achievement, when the achievement was unadjusted for student-intake characteristics. However, when the student characteristics were included, the variance explained was only 8% of the total variance in achievement measures. Based on these results, and on the research literature, the proportion of variance explained by the school is more modest than that explained by student characteristics. Nevertheless, it is evident that both the home background and the school influence achievement.

School Effectiveness in Mathematics Education

With the concerns about equity, the investigation into whether or not schools are effective in promoting achievement in mathematics has become a major avenue for educational research. Mathematics education researchers have derived many of the same conclusions as those discussed above through their research on mathematics achievement. Likewise, many of the same variables found to effect general academic achievement also impact students' achievement in mathematics. One of the most well known studies, the Second International Mathematics Study (SIMS), utilized variables from the student level and school level, as deemed important in the previous section of this paper. Of the many variables included in the analysis, expectations, total time on homework, class size, opportunity to learn, and teacher experience all evinced positive associations with mathematics achievement (Scheerens, Vermeulen & Pelgrum, 1989). Unfortunately, the use of the student-background variables was insufficient, and this is one of the main limitations of the study.

In contrast, Opdenakker et al. (2002) employed five student-level explanatory variables for the examination of the effect on mathematics achievement: initial cognitive ability, socioeconomic status of the family, achievement motivation, immunity to stress, sex, and language spoken at home. At the school level, the aggregates, or the proportions of the student-level variables, were included along with educational and counseling variables. The results indicated that the effect of the school and the student characteristics seemed to retain much of the same traits as in the meta-analysis by Scheerens and Bosker (1997). Nearly all the differences between schools could be explained (proportion of total variance) by student characteristics (45%), with only 5% of the total variance accounted for by school variables. Thus, this study found that while the results for variation in mathematics achievement were primarily due to student characteristics, school factors were also important.

Current Status

With the complexity evident in school effectiveness research, progress in understanding what factors account for variance in student achievement is a slow and ever-evolving process. Currently, the international research literature for school effectiveness shows that researchers should ideally include intake factors, school processes, and school characteristics in any study that aims to account for variation in student achievement (Goldstein, 1997). However, the interactions of these variables may be much more complex than previous research and the traditional research design allow (Goldstein, 1997; Opdenakker et al, 2002; Opdenakker & Van Damme, 2001; Rutter & Maughan, 2002). According to Creemers and Reezigt (1997), one probable outcome is that student achievement is most heavily influenced by specific configurations of factors, rather than by a quantity of isolated factors. For this reason, studies may limit the variables included in the analysis, in an attempt to find the configurations that best explain the variation in achievement.

While research has shown that schools cannot eliminate all of the effects of family background, the findings also suggest that student achievement can be influenced by the overall characteristics of school environment (Rutter & Maughan, 2002). With the intent to discover what "works" in effective schools, researchers focus on malleable conditions. In order to accomplish this goal, however, the significance or impact of the unalterable variables (student-background characteristics and school-context variables) must first be determined (Scheerens, Bosker & Creemers, 2000).

Thus, some researchers choose to focus on the configurations of unalterable variables, in order to gain a better understanding of achievement in schools. In doing so, the studies expand on the knowledge of school effectiveness through questions and theories about phenomena in education, especially the relationships between levels in the educational system (such as student, class, and school). This development and refinement of theories offer a foundation, as well as guidelines, for further understanding and future research (Goldstein, 1997; Scheerens & Creemers, 1989).

According to Scheerens (1993), school effectiveness research falls into one of three categories: fundamental studies, foundational studies, and applied studies (as cited in Creemers & Reezigt, 1997). The category each study belongs to depends on the purpose of the researcher. Fundamental studies are aimed at building models and theories and testing hypotheses. On the other hand, foundational studies focus on basic conceptual issues such as stability and consistency of effects. The last of the three categories is applied studies, which includes national assessments and indicator systems. Depending on the design and the intent of the study, the research categories can overlap. For example, the examination of a potential new phenomenon through a national or international assessment may build on a theory while utilizing an application.

Currently, international comparisons and differential effectiveness studies are two of the focal points in the examination of the role of schools in student academic achievement (Rutter & Maughan, 2002). Studies falling under these categories examine either the generalizability across contexts or the effectiveness of the relative performance of different subgroups of students (Creemers & Scheerens, 1994). Because these types of studies aim to establish conceptual boundaries for school effectiveness models, the school effectiveness research community has renewed their interest in this type of research.

Research on differences among subgroups and international comparative studies can both address the question of the configuration of factors impacting student outcomes (Creemers & Reezigt, 1997). While differential effectiveness studies might have more success in contributing or solidifying theories, international comparisons, innately limited in the choice of variables by design constraints, are better able to examine differences between countries. However, both can and do provide an integral explanation of the influence of student-background characteristics, school-contextual and compositional variables, and school-process and instructional variables on student achievement.

Because school effectiveness research identifies variables significant for effective schooling, this research area plays an integral role by providing a foundation for the guidelines and goals of school improvement (Lezotte, 1989). As suggested above, characteristics important to school effectiveness research often include the same characteristics studied in research on equity: SES, race/ethnicity, and school location. Therefore, the school effectiveness paradigm frequently includes this equity component in the research, even if it is not the focus. As such, research emphasizing equity in schools, including the proposed study on the impact of double jeopardy on mathematics achievement, is relevant within the framework.

Literature Review

Socioeconomic Status

Socioeconomic status (SES) is one of the most studied variables at both the student level (family SES) and the school level. Its distinction within the Coleman Report generated an interest in the academic achievement of disadvantaged students from the school effectiveness perspective (Creemers & Scheerens, 1994). Thus, within this framework, the use of various SES variables, at one level or another, integrates the extensive research with the question of equity in education.

Socioeconomic status has many definitions. One of the most common definitions defines SES as ranking "individuals on income, education, occupation, or some combination of these" in a hierarchy, which also might include power or prestige (Brinkerhoff, White, & Riedmann, 1997 as cited in Hsieh, 2002 p. 13). As a representation of multiple components, there is no one standard, widely accepted definition or designation for SES (Hsieh, 2002). However, because the various definitions often contain many of the same elements, the research utilizing SES as a variable appears to be fairly consistent with the results, especially as they concern mathematics achievement.

However, for general academic achievement, studies have shown more inconsistencies in the significance of SES. Mortimore et al. (1989) maintained that differences in circumstances between the advantaged and disadvantaged can substantially impact educational outcomes. Bruce Biddle (1997) also found that poverty, reinforced by poor funding in the poorest (disadvantaged) school districts, is responsible for the majority of the low achievement in the United States, according to the Third International Mathematics and Science Study (TIMSS) (as cited in Wrigley, 2004).

On the other hand, in a synthesis of 134 meta-analyses, Fraser (1989) indicated that SES did not seem to affect relationships with academic achievement. In contrast, according to Opdenakker and Van Damme (2001), an interaction of variables was found to influence the relationship of SES on achievement. This study indicated that when mean SES and mean numerical ability were analyzed together, the effect of mean SES disappeared. Thus, this result suggests that differentiating between a student's cognitive ability and family-SES background is an important step to understanding the effect of SES on achievement.

According to some critics of school effectiveness, the effects of SES on student achievement have been neglected; particularly the contextual effects (Scheerens, Bosker & Creemers, 2000). However, as the above studies indicate, the concern for the achievement of disadvantaged students has taken many forms over the decades, both at the student and the school levels. Unfortunately, some of the studies must work within limitations such as a lack of available information on family SES and the use of proxy variables for SES, such as the percentage or proportion of students eligible for free meals (Nuttall et al., 1989).

The patterns discussed above are also apparent for the more specific study of SES effects on mathematics achievement. As both the student and the school levels of SES have been utilized in the research, both will be reviewed in the following sections. The research will be grouped according to the level of SES and the type of definition used. With this approach, not only will the consistency of the results be apparent, but it will also indicate the extent to which SES has been a factor in the study of mathematics achievement.

Socioeconomic Differences in Mathematics Achievement at the Family Level

Student-level socioeconomic status (SES), or most often family SES, refers to the variable or variables measuring the socioeconomic level of the family for each individual student. Since its inclusion in educational research, the definitions utilized for family SES have been both varied and numerous, primarily as a result of the constraints of each study. According to White (1982), the most prevalent definition for family SES is based on a composite indicator of parents' education, parents' occupation, and family income. However, more recent studies have begun to include one or more measures, such as literacy resources in the home, educational resources in the home, and occupational prestige (D'Agostino, 2000; Lubienski, 2002; Papanastasiou, 2002; Wenglinsky, 1998). Typically, researchers are limited by the directives of their studies and thus, do not employ all of the above variables in their SES measure. In these cases, researchers construct the composite indicator by omitting the missing measure or by using a proxy measure for SES, such as "free or reduced lunch" (Abedi & Lord, 2001; Hughes, 2003).

Even with the multiple definitions utilized for family SES, the impact of student-level SES on education in general, and mathematics in particular, are remarkably consistent across studies: students with low family SES have lower achievement. This relationship holds true even with different age groups or grade levels. Based on the above definitions provided for SES, this literature review will divide the results of the studies into two groupings, with SES defined as either a composite indicator, or as the proxy measure free or reduced lunch.

SES Composite Indicator

For the past several decades, research has shown that socially and economically disadvantaged students continue to perform worse than students from more advantaged backgrounds. Two of the earliest and most well-known studies, the Coleman Report (1966) from the United States and the Plowden Report (1967) from the United Kingdom demonstrate the inextricable link between education and student-background factors, especially concerning the family's socioeconomic status (Kiviat, 2005; *Plowden Report, 1967*; Slee & Weiner, 2001). In a study of 1st, 3rd, 6th, 9th, and 12th graders, Coleman et al. (1966) concluded that a strong relationship exists between a composite indicator of SES and achievement (White et al., 1993).

Secondary analysis of the Third International Mathematics and Science Study (TIMSS) was the basis for several studies of the impact of family SES on mathematics achievement. This international study from 1995 contained data on three populations of students: 9 year olds, 13 year olds, and students in their final year of secondary school (Papanastasiou, 2002). For these studies, family SES was measured as the possessions that students have at home, such as literacy resources, calculators, dictionaries, and video recorders (Howie & Pietersen, 2001). In addition, the educational background of the family, typically the highest educational level of the father and the mother, was considered an indicator of SES.

Howie and Pietersen (2001) investigated the impact of SES on mathematics literacy from TIMSS for grade 12 students in South Africa. Specifically, this format concentrated on areas such as number sense, data representation, and estimation. The sample consisted of 2,757 12th-grade students from 90 schools. Two SES variables were used to measure family SES: the possessions in the home and the mother's education level. Stepwise linear regression indicated that both SES measures were of practical significance with correlations higher than .30. These predictors were found to be significant, even with the inclusion of age and language in the model. That is, after language, the SES of the student's home possessions was the most significant factor in this analysis. Similarly, the mother's education level was positively associated with a student's mathematics literacy. In fact, Howie and Pietersen concluded that SES is one of the most powerful predictors of mathematics achievement in South Africa.

Similar to Howie and Pietersen, Schreiber (2002) also employed a subsample of the TIMSS data. For this study, Schreider concentrated on the effect of parental education on advanced mathematics students in the United States. A two-level hierarchical linear model analyzed data from 1,839 students in 162 schools. This model indicated that parental education was a significant predictor of mathematics achievement, with students whose parents had less education scoring lower on the achievement test. Thus, Schreiber concluded that, like the average student population, economic disparities exist for the most advanced mathematics students.

Papanastasiou (2002) conducted a secondary analysis of the TIMSS data for Cyprus from population 2, the grade with the largest proportion of 13-year-old students. With a sample size of 1,026 8th-grade students, Papanastasiou investigated the effect of the SES measures of home possessions and highest education level of the father and the mother on mathematics achievement through structural equation models. Like the previous studies discussed above, this study found that the family educational background, which directly affected SES, also influenced mathematics achievement. Statistical differences evident in the mathematics achievement between students with parents of high educational background, and those with parents of low educational background, indicated that the educational background of the family influenced mathematics achievement through other predictors, including family SES.

In an earlier study of the TIMSS results, Papanastasiou (2000) found that students with a higher family SES performed better on the mathematics achievement test in both Australia and South Africa. In addition, in Australia, a disadvantaged background was the factor that most strongly correlated with mathematics achievement. These results, like those of the studies discussed above, concluded that SES impacted mathematics achievement (Howie and Pietersen, 2001; Papanastasiou, 2000/2002; Schreiber, 2002). Furthermore, even though four countries (South Africa, Australia, United States, and Cyprus) and various grade levels were examined from the TIMSS data, there was a consistency in the results. Thus, based on only the analysis of TIMSS, SES is a prominent factor in mathematics research.

Studies utilizing other data, and a variety of grade levels, have yielded similar results concerning family SES (Brown, 1991; D'Agostino, 2000; Kohr et al., 1989; McCoy, 2005). In a study of 107 8th-grade Algebra students from a North Carolina public school, McCoy (2005) concluded that family SES, as defined by the highest education level of their most educated parent, had a significant effect on the algebra achievement scores measured by both the North Carolina State End-of-Grade Mathematics Test and the North Carolina State End-of-Course Algebra I Test. Through analysis of variance (ANOVA), McCoy determined that these socially disadvantaged students were more likely to score lower on algebra achievement tests than more advantaged students.

Unlike the study by McCoy, Brown (1991) examined both initial mathematics scores and learning effects on the Beginning Teacher Evaluation Study (BTES) from a sample of six students for each of the 21 5th and 25 2nd-grade California classrooms, who were incorporated into the study. In contrast with many other SES studies, this study used the teacher to estimate the family SES variable, through the occupation of the "breadwinner". Based on this estimation, family SES was grouped into one of four categories. For the initial scores, analysis found that the mean score generally increased as the SES category increased; however, the relationship between SES and the initial scores was not statistically significant in most cases. As for the learning effects, only the mathematics for grade 5 evinced a pattern of greater learning effects for higher SES groups. While the results are not as conclusive as those from other studies, Brown does provide some support for the overarching influence of family SES on mathematics achievement and learning.

Similar to the 1991 study by Brown, D'Agostino (2000) focused on both initial mathematics achievement and learning rate in a study on the effects of instructional and organizational characteristics on longitudinal mathematics achievement. Using the United States Prospects data from the early 1990s, D'Agostino studied the effect of family SES on the above outcome variables. Family SES, as established in the research design, was comprised of parents' education levels, occupational prestige, family income bracket, as well as other factors relating to educational resources in the home. The research design, which used the family SES to differentiate the students' initial mathematics achievement levels, was based on the prediction that the family SES would remain constant for both mathematics subject and cohort. Hierarchical linear modeling showed a gap in students' mathematics achievement as early as the fall of first grade, in which low-SES students performed worse than high-SES students. While D'Agostino found that high-SES students' learning increased at a faster rate than low-SES students in mathematics for another year or two, by the 4th and 5th grades, the study indicated that the gap had not widened. Thus, the research shows that family SES is an important factor in both initial mathematics achievement and in the rate that students learn mathematics.

In an integrative study of family SES, race, and gender, Kohr et al. (1989) used the Pennsylvania Educational Quality Assessment Program of 1981-1984 to investigate mathematics achievement for students in the 5th, 8th and 11th grades. Parental education, parental occupation, and the amount of reading material in the home made up the composite indicator for family SES. Based on this SES measure, students were partitioned into low-, middle-, and high-SES subgroups. Kohr et al. then analyzed the data with a three-factor analysis of variance, determining that the main effects for family SES and race were statistically significant among students of all three grade levels. Furthermore, the contrasts between the low-middle and the middle-high student SES groups were statistically significant for all three grade levels. Thus, the results clearly demonstrated that mathematics achievement correlated directly with family SES.

Similar to many national or international databases, the National Assessment of Educational Progress (NAEP) databases have been utilized for numerous studies, many of which touch on the impact of family SES on mathematics achievement.

While both the treatment of family SES and the data utilized varies for each study, the conclusions have primarily supported the general consensus that there is a relationship between mathematics achievement and family SES (Byrnes, 2003; Lubienski, 2002; Weglinsky, 1998). Both Weglinsky (1998) and Byrnes (2003) used the 1992 NAEP mathematics data from the 12th-grade assessments to study the effects of student and school variables on mathematics achievement. While Weglinsky focused on family SES and school funding or spending among other variables, Byrnes included family SES in the analysis as a way to further examine the effect of ethnicity.

Each study constructed the family-SES variable from different measures. Weglinsky considered family SES to be a composite of (a) the highest level of education attained by the mother, (b) the highest level of education attained by the father, (c) and whether or not the family has or receives certain resources, such as a newspaper, magazines, an encyclopedia, and 25 books or more in the home. On the other hand, Byrnes determined family SES to be a composite of parental education and the number of parents at home. Using hierarchical linear modeling and hierarchical regression, respectively, the two studies concluded that a) even though a significant relationship exists between mathematics achievement and family SES within schools, it varies significantly, that b) the higher the level of median income, the more pronounced this relationship is within the school districts, and that c) parental education was found to be far more predictive of mathematics performance than ethnicity. With these results, the studies established even more support for the belief that family SES contributes to mathematics achievement.

In contrast, Lubienski (2002) investigated the effect of race and family SES on mathematics achievement for the 4th, 8th, and 12th grades on the NAEP mathematics assessments for 1990, 1996, and 2000. Family SES, as determined by parental education level and literacy resources in the home, was grouped into four levels with approximately 25% of the students at each level. As the study takes into consideration both race and SES characteristics, it was designed to show the achievement gap for Black and White students across SES categories. One conclusion indicated that the lowest SES White students consistently scored equal to or higher than the highest SES Black students, across the three grades in both the 1990 and 1996 data sets. While the results are not as clearly defined as the general conclusion that higher SES students score higher on mathematics achievement than lower SES students, the study does provide important implications for the treatment of family SES as it relates to race/ethnicity in future research.

Opdenakker and Van Damme (2001) and Opdenakker et al. (2002) published studies on the effects of student and school characteristics on mathematics achievement in Belgian secondary schools from the 7-year longitudinal project LOSO. While both studies incorporated the father's educational attainment as the indicator for family SES, they also included some of the following variables: sex, numerical intelligence, initial cognitive ability, and language at home. A multilevel analysis of 4,699 students, from 52 schools, and 276 mathematics classes showed a positive significant relationship between family SES and students' mathematics achievement (Opdenakker & Van Damme, 2001).

By the end of the first year of secondary school, Opdenakker and Van Damme found that mathematics achievement was a function of several variables, including numerical intelligence, family SES, and characteristics of the school environment.

Similarly, Opdenakker et al. (2002) examined the effect of student, teacher, and school characteristics through a sample of 1,936 students, from 131 mathematics classes, and 47 schools. The results from the correlational and multilevel analyses support previous research by indicating that family SES is predictive of mathematics achievement. Also, this study found that (a) the variance at the student level is a function of family SES, mean SES of the class, and interaction between the two, and that (b) mathematics achievement among students from low-SES families is more heterogeneous than the mathematics achievement of students from high-SES families. Thus, both studies examining the LOSO data support previous conclusions concerning the relationship of family SES to mathematics achievement; however, these studies also expand upon it by considering more variables and the possible interactions between levels in the analyses (Opdenakker & Van Damme, 2001; Opdenakker et al., 2002).

Similar to many of the above studies, Fotheringham and Creal (1980) found that a large portion of students who score poorly on achievement tests are from disadvantaged families. Analysis of a 1971 study of 1,153 3rd-grade students from Southern Ontario county in Canada affirm the conclusion that differences in family characteristics, including family SES as defined by a composite of parental occupation, education, and income, is a major influence on general academic achievement, and in particular, mathematics achievement.

Data from the National Longitudinal Survey of Youth (NLSY) was used to investigate the relationship among three types of influences: home environment, SES, and maternal test scores (Crane, 1996). Using multiple regression, Crane analyzed the data from 12,686 students for those variables significant in mathematics achievement. Specifically, family SES included the SES variables: family income, household size, and the percentage of students at the mother's high school who were considered poor. The results indicated that family SES, home influence, and maternal test scores all had fairly large effects in explaining the variation in mathematics scores. For all three facets of SES, Crane found that a standard deviation increase generated a one-third standard deviation rise in score. For this reason, this study shows that family SES impacts the mathematics achievement of students.

Reynolds (1991) examined 3,116 7th-grade students participating in the Longitudinal Study of American Youth (LSAY) in 1987 and 1988 for the effect of parental educational attainment (family SES), prior grades, parent expectations, urbanicity, and motivation on mathematics achievement. Reynolds concluded that the SES indicator used, parent education, had a moderately significant indirect effect on mathematics achievement. According to Walberg and Majoribanks (1976, as cited in Reynolds, 1991), this effect was mediated by social psychological variables, such as parent expectations and prior achievement. Even though the effect of SES on mathematics achievement was found to be indirect, a relationship was evident in this study. Thus, while the results support previous conclusions concerning the belief that family SES is an important factor in mathematics achievement, they also contend that family SES may also indicate other areas of concern.

Young (2000) drew similar conclusions through the examination of the data from the Western Australian School Effectiveness Study (WASES). This study investigated the effect of student and school variables on mathematics achievement for 1,024 students from 21 secondary schools in Western Australia in 1997. Both the mother and father's occupations were used to construct the SES of each student. Using a multilevel linear model, Young found that the significance of family SES was minimal (negligible) when prior achievement and other student-background characteristics (e.g., self-concept, grade) were incorporated into the model. As a result, Young suggested that the student's SES is not the "problem", but rather an indicator of other concerns associated with a disadvantaged background, such as expectations. Thus, unlike most of the studies that incorporate family SES as a variable, Young's conclusion does not support the overwhelming conclusion that SES impacts mathematics achievement.

Contrary to the results of Reynolds (1991) and Young (2000), most of the studies discussed provide support for the belief that family SES has some relationship with mathematics achievement, when it is defined as a composite of such factors as parental education, occupation, and educational resources. While the types of studies and their primary foci may differ, this is one conclusion that appears to be almost unanimously accepted throughout the literature when defined as above. However, because a composite indicator has not been the sole definition for family SES through the decades of research, such a generalized and strong conclusion of the importance of this factor cannot be reached without also looking at the other commonly used definition. Researchers primarily choose to use either the composite definition for family SES, as described above, or an indicator that is a proxy for SES, such as whether students are eligible for free or reduced lunches. As a result, the proxy indicator for family SES is the other definition explored in this literature review. However, unlike the numerous studies utilizing the composite indicator, the number of studies incorporating a student's eligibility for free or reduced lunches is limited.

Students Eligible for Free or Reduced Lunches

Two studies focusing on elementary school students reached similar conclusions that family SES is significant to mathematics achievement. Witthuhn (1984) examined family SES, while controlling for ethnic group and gender, in the Minneapolis Public Schools in 1982. Ten thousand two hundred twenty-five students in kindergarten, 1st, 2nd, and 4th grades were given benchmark tests in mathematics. Using analysis of variance, Witthuhn found that at every grade level both the total and subtest scores by SES were statistically significant. Similarly, Goddard et al. (2001) found family SES to be significantly and negatively associated with disadvantaged socioeconomic status for mathematics achievement. This result came from a study of 2,536 4th-grade students, in 47 urban elementary schools, in a large urban school district in the Midwestern United States. Using hierarchical linear modeling (HLM), with the variables prior student achievement, gender, race/ethnicity, and SES, the study illustrated the effect of family SES on mathematics achievement.

Contrary to the results by Goddard et al. (2001), research has also found that when family SES is coupled with prior mathematics achievement, the SES effect is no longer significant at the student level, even if it was significant before the inclusion of prior achievement (Muijs & Reynolds, 2003; Wang & Goldschmidt, 2003). The first of these studies considered teacher effectiveness in primary schools in the United Kingdom by examining the relationship between student social background, classroom social context, classroom organization, teacher behaviors, and mathematics achievement for 4,813 students in 36 schools (Muijs & Reynolds, 2003). The second study, by Wang and Goldschmidt (2003), investigated the relationship of family SES and mathematics achievement for the 8th-grade year (1994/1995), in a longitudinal study of 2,707 students from 17 schools in California (Wang & Goldschmidt, 2003). Analysis of the Mathematics Enhancement Project Primary (MEPP) by Muijs and Reynolds and the California Test of Basic Skills (CTBS) by Wang and Goldschmidt indicate the significance of family SES, except when prior achievement is controlled in the model.

Rech and Stevens (1996) conducted a study of the mathematics achievement of 4th and 8th-grade inner-city Black students as it related to mathematics attitude, self-concept, learning style and economic status. The sample of 133 4th graders and 118 8th graders was divided into three levels of SES, based on the eligibility to participate in the free (low economic status) or reduced (low-middle economic status) lunch program. Students not eligible were classified as middle economic class. Multivariate analysis of variance (MANOVA) on the California Achievement Test (CAT) showed that the economic status of students was not significant in the comparisons. However, when Rech and Stevens used stepwise regression, it was found that the 4th-grade sample indicated SES to be significant. At the 8th-grade level, SES was still not significant for mathematics achievement.

The Improving School Effectiveness Project (ISEP) study of Scottish primary and secondary schools also examined the impact of student background on achievement

(Smees et al., 2005). This longitudinal study included 8/9-year-old students from 44 primary schools, and 13/14-year-old students from 36 secondary schools. Multilevel analysis of the mathematics portion of the Scottish Assessment of Achievement Programme (AAP), which is the mathematics assessment for the ISEP, concluded that socially disadvantaged students are more likely to perform worse on mathematics achievement tests than other students. Specifically, both age groups demonstrated a significant relationship between SES and mathematics achievement.

The above studies primarily indicate that family SES, as defined by the student's eligibility to participate in the free or reduced lunch program, does have a significant relationship with mathematics achievement. Even though these studies incorporate a wide range of data, grade levels, and analysis techniques, the inclusion of family SES helps explain some of the differences among mathematics achievement scores. In other words, the results of these studies follow the same patterns established for the composite indicator. Furthermore, family SES was also found to be significant when the models included variables such as gender, ethnicity, and special-needs status. Only one variable, prior achievement, appeared to limit or eliminate the effect of family SES on mathematics achievement.

Socioeconomic Differences in Mathematics Achievement at the School Level

Research studies have examined socioeconomic status in numerous ways, one of the most common of which is the level of SES. As indicated above, family SES or student-level SES has influenced much of the educational research on school effectiveness for mathematics achievement. However, according to Hsieh (2002), researchers may not truly comprehend the effects of SES on schools if the focus reflects only the family SES. Consequently, even though the majority of the research on the impact of SES on mathematics achievement has focused on family SES, a portion of the research has concentrated on the impact of the school-level SES. Specifically, this type of research investigates school SES by examining how academic outcomes among the general student population are reflected in each individual school serving students from different SES backgrounds (Ma & Dundas, 2009).

For most studies, the results mirror the findings from research on family SES by indicating that school SES significantly impacts mathematics achievement. This is especially important, since at the school level, social-class background influences students' academic outcomes more than the effects of students' social-class backgrounds (Ma & Willms, 1997). Furthermore, Smees et al. (2005) assert that the proportion of students from socio-economically disadvantaged backgrounds is one of the most important contextual factors in which school intakes vary. Specifically, according to Kohr et al. (1989), students in schools with high percentages of disadvantaged students tend to have a higher likelihood of educational failure than students in other schools.

School SES refers to the variable or variables measuring the socioeconomic level of the school each student attends. Similar to family SES, school-level SES is also measured in different ways, including (a) aggregating the family SES to the school level, (b) considering the percentage of low-income families in the area served by the school, and (c) considering the percentage of pupils eligible for free school meals (Kohr et al., 1989; Smees et al., 2005; Yang, 2003). Of these definitions, the percentage of students eligible for free or reduced meals, is the measure most commonly identified in the research literature. For this reason, while all three measures will be considered in this literature review on the impact of school SES on mathematics achievement, the percentage of pupils eligible for free school meals will be considered separately from the other two measures.

Aggregating Family SES and the Percentage of Low-Income Families

As previously discussed, the LOSO study by Opdenakker and Van Damme (2001) found that family SES influenced students' mathematics achievement. However, this study also incorporated school SES as a variable. According to Teddlie and Reynolds (2000), "the SES makeup of a school has a substantial effect upon student outcomes beyond the effect associated with students' individual ability and social class" (as cited in Opdenakker and Van Damme, 2001, p. 184). This conclusion was substantiated when Opdenakker and Van Damme examined the effect of the mean school SES, deduced from the father's education level, on mathematics achievement in Belgian secondary education. According to the results, SES composition (school SES) had a significant effect on mathematics achievement when analyzed with and without school-process variables. However, when the model included both mean ability and school SES, the effect of school SES on mathematics achievement disappeared. Thus, while the school SES is significant in terms of mathematics achievement, the effect might be accounted for by other variables. Consequently, the influence of the school SES, while important, may not be as uniform as that of family SES.

Similar to Opdenakker and Van Damme (2001), an earlier study by Kohr et al. (1989) included both family and school SES in their analysis of the 1981-1984

Pennsylvania Educational Quality Assessment Program for 5th, 8th, and 11th grades. In this case, school SES, as determined by the percentage of low-income families in the area served by the school, was based on a composite of parental education, parental occupation, and the amount of reading material in the home. Kohr et al. conducted separate analyses on the data from the students attending low-SES schools and those attending high-SES schools. For all three grade levels, school SES demonstrated a significant relationship with mathematics achievement, emphasizing the tendency of students in low-SES schools to perform worse than students in high-SES schools.

Opdenakker and Van Damme (2001) and Kohr et al. (1989) show that when school SES is defined as an aggregate of a composite family SES, or the percentage of low-income families, the results are not uniform. The literature exhibits some discrepancy, with Kohr et al. supporting the conclusion that school SES impacts mathematics achievement, while Opdenakker and Van Damme found that the effect is actually minimal or negligible when combined with mean ability. Unlike the nearly uniform or virtually unanimous effect that family SES has on mathematics achievement, school SES, as defined above, is not nearly so easily addressed or characterized as an influence on student mathematics achievement. However, this difference could be the result of the limited number of studies incorporating this variable.

Percentage of Students Eligible for Free or Reduced Lunches.

Okpala et al. (2001) examined the effect of school-level SES on the mathematics achievement scores of 4th-grade students in North Carolina. For this study, 42 schools, with approximately 4,256 fourth graders, participated during the 1995-1996 school year.

The results indicated that the proxy for school SES, the percentage of students in free or reduced lunch programs, was negatively related to the students' mathematics performance. Specifically, Okpala, Okpala, and Smith found that the percentage of students mastering mathematics increased greatly from low-SES to high-SES schools. Thus, this conclusion supports the findings from the research literature that a relationship between economic circumstances and academic achievement, particularly mathematics achievement, exists.

As previously discussed, the analyses of data from the Improving School Effectiveness Project (ISEP) study of Scottish primary and secondary schools by Smees et al. (2005) indicated that socially disadvantaged students are more likely to perform worse on mathematics achievement tests than other students. When the analyses concentrated on school SES, the results supported the conclusion by Okpala et al. (2001), in which the performance levels for mathematics tended to be depressed in schools with a high percentage of disadvantaged students. The results indicated that a) the relationship between school SES and mathematics achievement was significant for both the 8/9-year-olds and the 13/14-year-olds, and that b) low-SES schools were at greater risk for lower scores by all students. Furthermore, this study showed that the SES composition of the school influenced student performance on achievement tests over and above their own characteristics. Thus, according to this study, the influence of school SES is not negligible when compared to student-background characteristics.

In an investigation of school accountability in Kentucky, Reeves (2003) focused on the effects of school SES and school location for 1,115 public schools, from 171 school districts, on the Mean Accountability Index for school performance for the 1999-

2000 school year. Along with the school-SES and school-location variables, Reeves incorporated the percentage of Black students, school membership, and student/teacher ratio as control variables. Analysis of the two-level hierarchical linear model showed that (a) the effect on the school performance was primarily due to the school SES, and (b) that the effect size was large. Thus, this research study provides evidence that school SES, even with control variables and taking into account for school location, influences academic achievement, which includes components of mathematics achievement.

In 1998, D'Agostino et al. published a study examining the connection between high poverty schools and longitudinal academic achievements, especially mathematics achievement, for two cohorts from the Prospects data (1991 to 1994). A Math Concepts and Applications subtest from the CTBS/4 and the total math scores of the Comprehensive Test of Basic Skills, Fourth edition (CTBS/4) were the outcome measures for the 1st- and 3rd-grade cohorts, respectively. For each hierarchical linear model, D'Agostino et al. defined high poverty or low-SES schools as schools with at least a 50% poverty rate, based on the number students in the school who received free or reduced lunches. In determining the relationship between the school-level compositional variables and student mathematics growth from 1991 to 1993, the study concluded that a) for the first grade cohort, schools with greater rates of school poverty contained students with lower learning rates, and b) for the third grade cohort, the students in the higher-poverty schools had lower initial achievement levels in mathematics, but grew more over the period of study than students in lower-poverty schools. Thus, this study supports previous literature on the effect of school SES and mathematics achievement, showing the tendency of low-SES schools for lower mathematics achievement and lower rates of learning.

Similar to the above studies, Hsieh (2002) also concluded that school SES influenced mathematics achievement. Through secondary analysis of the National Educational Longitudinal Study of 1988, Hsieh examined the effect of school SES, school location, and student ethnicity on 10th-grade mathematics achievement. According to Hsieh, the results supported the general consensus that high-SES schools outperform middle-SES schools, which outperform low-SES schools in mathematics achievement. Furthermore, the findings indicate that a) all pairings of school SES had statistically significant differences, and that b) the students from high-SES schools scored educationally significantly higher on mathematics achievement than students from low-SES schools. In short, this study reinforces the results that currently prevail in the literature: school SES impacts mathematics achievement.

Both Winters (2003) and Muijs and Reynolds (2003) also substantiate the above findings that school SES influences mathematics achievement. Using analysis of variance, the Pearson r correlation test, and multiple regression analysis, Winters concluded that a significant negative relationship between the school mean and school SES existed on both the ACT Mathematics Test and the TCAP Mathematics Test. Specifically, as the percentage of students receiving free or reduced meals increased in the schools, the mathematics achievement decreased.

Similarly, Muijs and Reynolds (2003) found school SES to be a significant indicator for mathematics achievement. While a wider study of the data from the Mathematics Enhancement Project Primary (MEPP) for Welsh and English primary schools examined teacher effectiveness through student-background variables, classroom variables, and school-level variables, this study used multilevel analysis to investigate the effect of school-contextual variables on mathematics achievement. According to Muijs and Reynolds, school SES was the only contextual variable statistically significant concerning mathematics achievement. Thus, the percentage of students receiving free or reduced meals did in fact impact mathematics achievement.

Contrary to the research detailed above, Goddard et al. (2001) did not conclude that school SES was a significant predictor of mathematics achievement. This result was obtained through the analysis of 2,536 4th-grade students, from 47 schools, in one district in the Midwestern United States. While hierarchical linear modeling showed a significant and negative relationship between mathematics achievement and disadvantaged SES, a school-level impact of SES, similar to that found in other studies, was not in evidence. However, school SES was not examined separately for its impact on mathematics achievement, but rather in a combined model with family SES and other variables. This combination could have influenced the results of school SES, and this will be addressed further in the next section of the literature review.

According to this literature review, a distinct difference can be seen between the effect of school SES and the effect of family SES on mathematics achievement. While family SES appears to consistently impact students' scores on achievement tests for mathematics, indeterminate of the many variations and variables inherent in a study, school SES shows a greater effect on mathematics achievement when the variable used is the percentage of students eligible for free or reduced meals. However, even within this definition, Goddard et al. (2001) did not conclude that the effect was significant.

Similarly, when the school SES was defined as an aggregate of parents' education, occupation, and other variables, the lack of influence was even more notable. Both Young (2000) and Opdenakker and Van Damme (2001) maintained that the effect of school SES was not the "problem," especially when other more relevant variables were included in the analysis. However, even with these discrepancies, the literature appears to generally support the assertion that school SES is important to mathematics achievement.

Socioeconomic Differences in Mathematics Achievement at the Family and School Levels

As evidenced by the above literature review for SES, many studies over the past four decades have focused on either family SES or school SES. Unfortunately, few studies have analyzed both levels of SES, either separately or simultaneously. Two studies, Opdenakker and Van Damme (2001) and Smees et al. (2005), addressed each level of SES independently, instead of through simultaneous investigation. In contrast, Yang (2003), Goddard et al. (2001), Kohr et al. (1989), and Ma and Dundas (2009) investigated the concurrent effect of both family SES and school SES. As the following synopses will show, the above studies concluded that (a) separately, both family and school SES had significant effects on mathematics achievement, and that (b) when evaluated in the same model, both family and school SES remained mostly significant.

Independent Treatment of SES Levels

As previously cited, Opdenakker and Van Damme (2001) found significant effects on mathematics achievement for both SES levels. When analyzed, the data indicated that (a) family SES was positively related to mathematics achievement and that

(b) while school SES had a significant effect on mathematics achievement, the effect disappeared when school SES was analyzed in conjunction with mean ability. This study also concluded that school-composition variables, including school SES, have an additional positive effect on mathematics, independent of the student-background variables. Because the study addressed other school and student variables, when the effect for school SES disappeared with the inclusion of mean ability, the final model did not incorporate both SES levels together in the analysis.

Similarly, Smees et al. (2005) concluded that students from low-SES homes achieve lower scores on mathematics achievement tests than students from higher-SES homes. This same study also determined that the level of mathematics performance or achievement tended to be depressed in schools with high percentages of disadvantaged students. While the contextual model did not analyze student achievement in mathematics simultaneously, for both SES variables, the longitudinal model incorporated both family and school SES in the analysis of students' growth in mathematics achievement. Overall, this study implied that the influence of school SES is not negligible, when compared to family SES; however, the model that served as a basis for this conclusion was not specified. As a result, the importance of this study, and the study by Opdenakker and Van Damme (2001), lies in the separate, but significant results of the analyses on family and school SES.

Simultaneous Treatment of SES Levels

Within the subset of studies that examined both family SES and school SES, there are few that have considered the two simultaneously (Yang, 2003). The scarcity of studies focusing on this concurrent exploration of SES levels reflects a hole or void in the research literature on the impact of SES on mathematics achievement. According to Opdenakker et al. (2002), researchers have begun to comprehend that the complexity of the relationship between student-background characteristics and school composition affects analysis, as well as the subsequent conclusions drawn about academic achievement. Specifically, the simultaneous investigation of family and school SES addresses the complexity and inherent relationship between the two variables in a manner that illuminates how SES influences mathematics achievement.

Yang's (2003) research on the dimensionality of SES in relation to mathematics and science achievement for 17 countries (including most European countries, USA, Canada, Hong Kong, and Singapore) from TIMSS attempts to address the above gap. This study identified two student-level dimensions of SES, economic capital and cultural capital, and one school-level dimension, general capital, as relevant to mathematics achievement. Evaluation of the two-level model indicated that the model for SES is acceptable for all the countries in this analysis. However, because the focus of the study is on the dimensionality of SES and the goodness of fit of the model, instead of on the extent of the impact of family and school SES on mathematics achievement, it does not provide much information relevant to this paper. Nevertheless, the study does signify that aspects of both levels of SES are acceptable for models attempting to explain mathematics achievement.

Studies by Goddard et al. (2001), Kohr et al. (1989), and Ma and Dundas (2009) have also included models that contain both levels of SES variables. However, unlike the majority of studies incorporating only one SES variable, these particular studies have reached varying conclusions, many of which reflect other variables or elements. Specifically, teacher trust, race, and school location may have influenced the results for each respective study. Therefore, generalities explaining the differences among schools in mathematics achievement, as they relate to both SES variables, may be difficult to ascertain with the limited amount of research.

As previously discussed, Goddard et al. determined that the relationship between mathematics achievement and disadvantaged SES were both significant and negative. In addition, research into teacher trust indicated that school SES was the largest predictor of variation between schools. As a result, school SES was included in the model examining mathematics achievement between schools. Through this model, both family and school SES were analyzed simultaneously; however, the results attributed different significance to the SES variables. While Goddard et al was unable to conclude that school SES was a significant predictor of mathematics achievement, family SES remained significant.

Kohr et al. (1989) also incorporated both family and school SES in a study on SES, race, and gender. An analysis of variance on the three partitions of family SES – low, middle, and high SES – found statistically significant main effects for each partition. The findings indicated that mathematics achievement varied directly with the family-SES level, and that for all three grade levels (5th, 8th, and 11th), the contrasts between the low-middle and middle-high SES groups were statistically significant.

While school SES was not examined separately in this study, Kohr et al. did include a supplementary analysis of mathematics achievement with family SES, school SES, and race. This analysis showed that all three variables had significant main effects for all three grade levels; however, there was no interaction effect found for family and school SES. Even without the interaction, the results support the conventional conclusion that SES differences are related to student mathematics achievement. Clearly, this study shows that students in low-SES schools, and students of low-SES backgrounds, tend to perform poorly in school when compared to their high- and middle-SES counterparts. However, because this research also found significant interaction between race and school SES, the interpretation of the effect of SES on mathematics achievement may be confounded by this variable.

Of the studies investigating both family SES and school SES, Ma and Dundas (2009) focus primarily on the concurrent analyses of the two levels of SES. Unlike many of the previous studies discussed above, this study further subdivides SES. Ma and Dundas analyzed three student-level SES variables and their school level counterparts: father's SES and mean father's SES, mother's SES and mean mother's SES, and family SES and school SES. However, the research design also included school location, which was used to initially separate the student population into one of four categories (rural area, town, city, and big city) prior to commencing the study. Therefore, for each SES variable, there are four results relative to the school location. A concurrent student and school-level model, the "double jeopardy model", indicated that both student-level SES and school-level SES were significant for father's SES and family SES in rural areas, towns, and cities. Neither mother's SES, nor the big city locations showed any significant relationship between both SES levels and mathematics achievement. Based on these results, Ma and Dundas concluded that both the manner in which SES is defined (i.e., by parent contribution) and the school location regulate the effect that SES has on mathematics achievement.

Conclusions

As shown through this literature review, only a limited amount of research examines both family SES and school SES. Opdenakker and Van Damme (2001) found that both family and school SES were significant when studied separately, but they also indicate that the addition of mean ability rendered school SES no longer significant in the model. Smees et al. (2005) also ascertained that both variables were significant for mathematics achievement; however, the longitudinal model for progress was the only model that examined both variables together. Unlike the above studies, Yang (2003), Goddard et al. (2001), Kohr et al. (1989), and Ma and Dundas (2009) analyzed the effect of SES on mathematics achievement by incorporating both family SES and school SES in the same model. Most of the findings indicate that both variables remain significant when evaluated in this manner (Kohr et al., 1989; Yang, 2003). However, Goddard et al. could not conclude that school SES remained significant. Also, Ma and Dundas found that the concurrent significance of both levels of SES depended on (a) the type of SES and (b) the school-location variable. Consequently, the limited number of studies, and the variety of results, indicates that more research must be done in this area to adequately understand the results and the effect of other variables.

School Location Differences in Mathematics Achievement

The widespread effect of SES on mathematics achievement reflects a fundamental deficiency in terms of equity in the educational system. Another variable, school location, also raises questions of equity for mathematics achievement in schools (Wenglinsky, 1998). In fact, two common generalizations believed by educators, researchers, legislators, and the general public have facilitated heightened interest in the effect of school location on achievement: (a) students in small rural schools and large urban/inner-city schools receive an inferior education when compared to the education received by students attending suburban and urban schools, and (b) the academic achievement of the students reflects this inferior education (Young, 1998). Consequently, research investigating the relationship between school location and mathematics achievement has become an important subject for educational research. However, as this literature review will show, the results have been far from consistent.

School location refers to the location of the school in terms of the urbanicity or rurality of the community (e.g., rural, suburban, or urban school), as well as the school's placement within community (Reynolds, 1991). Similar to socioeconomic status, researchers utilize numerous definitions for school location. These definitions are often based on one or more of the following: population density, economic activity, size of place, geographic dispersion, or culture of the residents (Webster & Fisher, 2000; Winters, 2003). According to the literature, the majority of the studies on school location examine the variable in one of three ways: rural vs. nonrural, rural vs. urban, or rural vs. suburban vs. urban. For this reason, each separate category will be discussed independently of the others, in an effort to further clarify the effect of school location on mathematics achievement.

Rural vs. Nonrural

Researchers interested in the effect of rural schools on achievement sometimes design their study as a comparison of rural schools and nonrural schools, or all schools not considered rural. Rather than representing a majority of the literature on school location, this classification describes the portion of the research primarily interested in the above comparison. As such, these studies focus on the differences attributable to rural schools. According to Lee (2001), the importance of the rural school lies in the belief that (a) typically, rural schools are small and contribute to better achievement by disadvantaged students, and that (b) rural schools may endure poor educational conditions such as limited courses and unqualified teachers. These two beliefs lead researchers to investigate the supposition that the advantages and disadvantages of the setting affect the students' academic performance.

According to the National Center for Education Statistics, in 1991, the achievement scores of rural students in the United States has been comparable to national averages in virtually every subject tested (as cited in Lee, 2001). In 1996, the National Assessment of Educational Progress (NAEP) determined that rural students began to outperform nonrural students on the mathematics assessment for the 8th grade (NCES, 1997). In other words, this national data indicates that the performance of rural students in mathematics increased from achievement below or equal to that of nonrural students. Therefore, as the above comparison shows, any inconsistencies in the results could be a reflection of the year in which the data was collected for the study.

However, a study by Lee and McIntire (2000) also found inconsistent results from the NAEP 1992 and 1996 8th-grade mathematics assessment data, when comparing rural and nonrural students in the United States. For this study, Lee and McIntire separated the schools into two categories, based on the population located around the school. Specifically, schools in rural or small towns (with less than 25,000 people) were designated as “rural,” while schools in central cities, urban fringes, and large towns were designated as “nonrural.” Significant interstate variations were found among data from the 35 states comprising the study. While 14 of the states reported statistically significant differences in mathematics achievement, due to the status of rural or nonrural, the results did not establish a single or consistent direction for the achievement gap across all 14 states. Specifically, the analysis for 7 states (Connecticut, Indiana, Massachusetts, Michigan, Nebraska, New York, and Rhode Island) indicated that rural students performed better than nonrural students. In contrast, nonrural students outperformed rural students in Georgia, Kentucky, Maryland, North Carolina, South Carolina, Virginia, and West Virginia. Nationally, rural students scored comparably with the nonrural students in the 1992 assessment, while eventually outperforming the nonrural students in 1996. Therefore, as Lee and McIntire illustrate, the results on a national level can be different when examined on a state-by-state basis, with rural students performing the same as, worse than, or better than their nonrural counterparts. In this case, the variations in mathematics achievement from state to state may be a result or reflection of the different social and cultural characteristics of the rural and nonrural areas in each state.

Analysis of the 2002 Tennessee School Report Cards showed significant differences in mathematics achievement between 8th-grade rural and nonrural students on the Tennessee Comprehensive Assessment Program (TCAP) achievement test (Winters, 2003). For this study, Winters used the locale codes from the National Center for Education Statistics to classify the schools as rural or nonrural, based on geographic location, population, and population density. Schools in small towns and in rural areas, both inside and outside metropolitan areas, were designated as rural schools, while schools in large towns, large cities, and mid-sized cities, as well as the urban fringe, were defined as nonrural.

Analysis of variance, Pearson r correlation tests, and multiple regression analysis indicated that rural students significantly outperformed nonrural students on the TCAP mathematics achievement test; however, no significant differences were found for the 12th-grade ACT mathematics achievement test. As such, Winters reached a conclusion similar to that of Lee and McIntire: variation exists in the results concerning the mathematics achievement of rural and nonrural students. However, unlike the major inconsistencies in the state-by-state analysis, Winters found that the direction of the achievement gap remained the same, with rural schools attaining higher means on both the ACT and the TCAP mathematics tests. In short, the results of these studies by Lee and McIntire (2000) and Winters (2003) reflect the ambiguity of the effect of rural and nonrural location of schools on mathematics achievement.

Rural vs. Urban

Contrary to the studies discussed above, the rural versus urban categorization of schools focuses on the comparison between the two school locations typically stereotyped as the least successful in mathematics achievement. As such, these comparisons tend to reflect potential differences among the school environments that may affect mathematics learning (Reynolds, 1991). According to McCracken and Barcinas (1991), urban and rural schools differ in school size, staff size, and financial and curricular resources. In terms of background characteristics, the ethnicity, SES, and education level of the parents also varies between urban and rural students. Moreover, differences exist between the two school locations in how the community interprets the fundamental purpose of schooling. For urban areas, the community tends to view schools as a means for producing societal change, while rural areas sees schools as mechanisms for community cohesion (McCracken & Barcinas, 1991).

The numerous disparities between rural and urban schools suggest that research into this topic will exhibit inconsistent findings concerning which group of students performs better on mathematics achievement. In fact, this lack of consistency in the results is evident in the following studies. Randhawa (1988) and Randhawa and Hunt (1987) found that students from rural schools performed better than students from urban schools on assessments over mathematical concepts (as cited in Cox, 2000). However, a more recent study by Teese, Davies, Charlton, and Polesel (1995) contradicted these results, instead concluding that rural students had lower achievement than most urban students (as cited in Cox, 2000).

Young (1998) further substantiated the conclusion of Teese, Davies, Charlton, and Polesel. Young investigated the mathematics achievement of rural and urban students in Western Australia through the first wave (1996) of the Western Australia School Effectiveness Study (WASES). This study grouped schools in small rural centers, other rural areas, remote centers, and other remote areas as rural. Metropolitan schools remained in the urban category. Multilevel analysis of the 3,397 secondary students in 28 schools found a strong negative effect for mathematics achievement, indicating that the more rural and remote schools had significantly lower mathematics achievement. Moreover, school location accounted for 21.5% of the variation in the scores. This effect was determined after SES, sex, Aboriginality, English speaking background, academic self concept, grade, and average SES were incorporated into the model. This study concluded that school location had a significant effect on mathematics achievement, with students from urban schools performing better than students from rural schools, even after incorporating other school- and student-level variables. In other words, Young found that rural students tend to be at a disadvantage in their mathematics achievement.

Young (2000) further examined the effect of rural and urban schools on mathematics achievement in Western Australia through the 1997 WASES data. Similar to the previous study by Young, this study controlled for other variables including gender, academic self-concept, grade, and prior achievement. Also, the same designations for rural and urban schools were utilized. Data from 1,024 students in 21 high schools was analyzed through analysis of variance. The results indicated significant differences between schools from both the urban and rural locations. Specifically, Young noted that mathematics performance tended to be lower for students from remote centers. However, when a multilevel linear model was utilized to investigate the effect of school location on mathematics achievement for the above variables, the effect of school location was minimal, with no apparent rural disadvantage. Thus, this study reflected both a rural disadvantage among students from the remote centers and no disadvantage by school location.

The conclusion that rural students are at a disadvantage in mathematics achievement was also substantiated through the analysis of mathematics achievement on of the Victorian Certificate of Education in Victoria, Australia (Cox, 2000). This investigation utilized the 1992 VCE database, which contained records of 45,206 students, who were enrolled in at least one VCE year 12 mathematics class in either metropolitan or country schools. For each of the six mathematics subjects, students were assessed via the Four Common Assessment Tasks (CAT), which included an investigation, a challenge problem, facts and skills, and analysis. Of the twenty-four assessments, the MANOVA analyses indicated that approximately two thirds of the differences favored the metropolitan or urban students, with significant differences on 10 of the assessments. In contrast, rural students only performed significantly better than their urban counterparts on 2 of the assessments. Thus, this study found that while the results do vary to some degree, the urban students typically achieved better scores than the rural students. Consequently, Cox concluded that a disadvantage exists for rural students, especially on the first three CATs.

According to this literature review, studies have found some discrepancies on whether rural or urban students perform better on mathematics achievement. Randhawa (1988) and Randhawa and Hunt (1987) both concluded that the disadvantage lies in the urban school location, while Teese, Davies, Charlton, and Polesel (1995), Young (1998), Young (2000), and Cox (2000) indicated that rural students had a disadvantage in mathematics. In other words, evidence of a rural disadvantage in mathematics performance is apparent only for the more recent studies. Moreover, this result may indicate the current status of school location's impact on mathematics achievement.

Rural vs. Suburban vs. Urban

Alongside the research on rural vs. nonrural schools and rural vs. urban schools, researchers have also examined rural, suburban, and urban schools for the purpose of comparing academic achievement. The addition of suburban schools into the research on rural and urban schools is a logical extension of previous studies, which indicate that differences in the school locations might be the reason for the significant differences in mathematics achievement. Thus, when researchers expand the school location categories to include suburban schools, they show another distinctive type of school that can influence achievement. While the research is more limited for this treatment of school location, the results tend to illustrate some of the same inconsistencies. For example, Fan and Chen (1999) found no apparent differences in mathematics achievement between the school locations. In contrast, Hsieh (2002) supported the general consensus that students in suburban schools outperform students in urban schools, who outperform students in rural schools.

Fan and Chen (1999) used the National Educational Longitudinal Survey (NELS: 88) to compare the mathematics achievement of rural students with their suburban and urban counterparts. Three waves of data (8th grade in 1988, 10th grade in 1990, and 12th grade in 1992), consisting of approximately 24,000 students, were analyzed separately as three nationally representative samples using multivariate analysis of variance (MANOVA). All three grades, when separated by ethnicity, indicated that differences in mathematics achievement, based on school location, were almost nonexistent in the analysis of variance (ANCOVA), and that the effect size measures were too small for practical significance. With the inclusion of the region variable into the analyses, Fan and Chen concluded that, for the 8th-grade data, some advantage was found for rural students in the Midwest region; however, for other regions, practically no differences appear to exist. The 10th-grade data also indicated some differences for school location in the Midwest region. Unlike the previous two waves of data, the 12th-grade data show less consistent results among some locales, favoring rural students, while others favor urban students in mathematics achievement. None of the analyses suggested that suburban students achieved significantly better than their rural or urban counterparts. Therefore, this study concluded that a) there were practically no significant differences for mathematics achievement by school location, and that b) rural students performed comparably to suburban and urban students (Howley & Gunn, 2003).

Unlike Fan and Chen (1999), who found no significant differences between rural, suburban, and urban schools in mathematics achievement, Hsieh (2002) concluded that student performance on mathematics assessments followed a general trend, with the highest achievement attributed to suburban students, followed by urban students, with rural students scoring the lowest in mathematics achievement. This conclusion resulted from an investigation into the differences in mathematics achievement due to school location, school SES, and student ethnicity. Hsieh used t-tests to analyze the 10th-grade database from the National Educational Longitudinal Survey (NELS: 88), which categorized school location based on the metropolitan statistical area (MSA) classification. Analyses showed statistically significant differences between suburban and urban students and between suburban and rural students; however there were no educationally significant differences found for school location. Thus, even though this study supports the general trend discussed above, the lack of educationally significant differences tends to support the conclusion that there are no major differences in mathematics that are attributable to this classification of schools.

As the studies by Fan and Chen (1999) and Hsieh (2002) illustrate, the literature on the effect of rural, suburban, and urban schools concerning mathematics achievement contains studies with varying and often contradictory results. Even though both studies used the same database, differences in the design and analysis might have resulted in the different conclusions. As such, it is difficult to directly compare these studies; however, one conclusion can be drawn: the results for studies comparing rural, suburban, and urban schools are inconsistent.

Summary for School Location

With the increased emphasis on the effect of school location in educational research, the research literature has begun to identify one fundamental pattern: the results are inconsistent (Hsieh, 2002; Fan & Chen, 1999). The conflicting results are often related to the definitions or groupings of the school locations, the designs of the studies, and the data utilized. Because the number and types of school location in each study determine in the most fundamental of ways the effect on mathematics achievement, a basic understanding of the patterns associated with the various groupings is necessary to evaluate the overall effect of school location. For this reason, the literature review was organized according to the three main school groupings: rural vs. nonrural, rural vs. urban, and rural vs. suburban vs. urban.

Research for the rural and nonrural comparison indicated that a) no significant differences existed in mathematics achievement, that b) rural students outperformed nonrural students, and that c) nonrural students outperformed rural students (Lee & McIntire, 2000; Winters, 2003). While none of these results carry more weight than the others, they do reflect both positive and negative characteristics affecting rural schools. The second grouping compares rural schools with urban schools. In this case, even though the results were similar to those of the rural and nonrural schools comparison, there appears to be more indication of a rural disadvantage (Cox, 2000; Teese, Davies, Charlton, & Polesel, 1995; Young, 1998/2000). In contrast, the final classification primarily indicated no significant differences for rural, suburban, and urban schools concerning mathematics achievement (Fan & Chen, 1999; Hsieh, 2002). Nevertheless, some portions of the studies favored rural, urban, or even suburban students. However, either the limited nature or the lack of practical significance in the studies led researchers to conclude that no differences in mathematics achievement occurred as a result of school location. The conclusions appear to challenge a general trend that suburban students outperform urban students, and urban students outperform rural students.

Based on the above summary of results, no overwhelming conclusion can be made to support the contention that one type of location has a greater positive or negative effect on mathematics achievement (Reeves, 2003). Because of this, researchers have suggested that variables such as SES, availability of resources, and parental involvement may confound the results, and they should be included in any future studies on school location and mathematics achievement (Fan & Chen, 1999). Also, according to Levine and Lezote (1990), three types of school contexts should be included in school effects research: school SES, grade level of schooling, and school location (as cited in Young, 1998).

School location and SES

Even though many variables have the potential for confounding the effect of school location on mathematics achievement, SES appears to be the primary characteristic addressed in research. For example, comparisons of rural and urban schools by Young (1991/1994/1995) and Young and Fraser (1992/1993/1994) show that the effect of SES on student achievement is significant (as cited in Young, 1998). While these studies do not support one conclusion over another for school location, they do indicate that the actual characteristic measured in studies of rural and urban differences is either SES or ethnicity. According to McCracken and Barcinas (1991), schools tend to magnify the impact of the differences of background characteristics between rural and urban students, especially for SES.

Hampton, Ekboir, and Rochin (1995) determined, through a study of 100 rural communities, that the principal predictor of academic achievement for rural schools is family SES. This conclusion was reached after regression analyses of the California Assessment Program (CAP) for 3rd, 6th, and 12th grades showed a large and significant positive SES influence on the achievement. Furthermore, when this study is considered in conjunction with a study by McCracken and Barcinas (1991) it supports the hypothesis that the difference in SES for school location could impact academic achievement.

Analysis of data collected from 12th graders, in 10 rural and 5 urban schools, in 1989 indicated that family SES was much lower for rural families than for urban families (McCracken & Barcinas, 1991). With these results, McCracken and Barcinas provide further justification for the existence of SES differences between rural and urban students. Moreover, Alspaugh (1992) found that rural and urban students seem to differ concerning the impact of SES on school achievement. Consequently, with both SES and school location differences in evidence in studies on the effect of school location on student achievement, both variables should be included in the analysis.

However, according to Khattri, Riley, and Kane (1997), previous research has often obscured the effects of SES and school location: "Most of the data available on student outcomes are not disaggregated by location and poverty, and little available research uses both variables simultaneously in examining such differences. … the degree to which geographic location plays a role, after poverty is taken into account, is not apparent" (as cited in Reeves, 2003, p. 85). Fortunately, after years of examining these two characteristics separately, more researchers have begun to incorporate both elements into the research design, thus filling a void in the research literature (Hsieh, 2002). This design enables researchers to form better conclusions about the individual and simultaneous impact of SES and school location on academic achievement.

Reynolds (1991) examined data from the 1987-1988 school year for 3,116 7th-grade students participating in the Longitudinal Study of American Youth (LSAY) for the effects of urbanicity (rural, suburban, or urban school location) and parental educational attainment (proxy for family SES) on mathematics achievement. When analyzed alongside sex, grades in 6th grade, parental expectations, and motivation, Reynolds determined that parental education had significant indirect effects on mathematics achievement. However, the study found practically no effects on mathematics achievement relating to school location.

Alspaugh (1992) conducted a study investigating the relationship between SES, school location, and academic achievement. This study considered the performance of fifth graders in reading, mathematics, science, and social studies on the Missouri Mastery Achievement Test (MMAT) for 106 rural and 39 urban/suburban elementary schools. Alspaugh found little difference by school location in the average achievement levels for the total performance on the MMAT. However, the SES measures (percentage of free or reduced lunches, percentage of two parent families, percentage of mobility, and percentage of minority) appear to account for the differences in achievement between the rural and urban schools. Specifically, the percentage of students receiving free or reduced lunch was the most highly correlated variable with mathematics achievement.

Similar to Reynolds (1991) and Alspaugh (1992), Fan and Chen (1999) found practically no significant differences in achievement relating to school location on the National Educational Longitudinal Survey (NELS: 88) data for reading, science, and mathematics. Analyses of the 8th-, 10th-, and 12th-grade data showed that rural students performed comparably with their suburban and urban counterparts. However, the study also indicated that the common achievement differences were attributable to SES. Thus, all three studies concluded that SES is more influential on academic achievement than school location.

More recently, Reeves (2003) designed a study to disentangle the effects of SES and school location through the hierarchical linear modeling of school and district level data using the Mean Accountability Index for Kentucky school performance. Even though this study does not specifically address mathematics achievement, the outcome variable for school accountability does include a mathematics dimension. With this in mind, the data from the 1999-2000 school year for 1,115 public schools in 171 school districts was analyzed for school SES (percentage of students receiving free or reduced lunch) and school location (metro or nonmetro). Using the classification scheme from the Urban Influence Codes of the Economic Research Service of the U.S. Department of Agriculture, Reeves defined “nonmetro” as any school falling under one of the following four categories: adjacent to metro, town < 2500, town 2500-9999, and town >10,000. The results indicated that a) the effects on school performance were mainly attributable to SES and not school location, and that b) the size of the effect was large. However, the study also found that a nonmetro school location reduced the negative influence of SES on school performance. Unfortunately, this effect was small and did not counteract the negative impact of SES. Thus, like Reynolds (1991), Alspaugh (1992), and Fan and Chen (1999), Reeves also found SES to be more influential on achievement than school location.

In contrast, Young (1998), Webster and Fisher (2000), Hsieh (2002), and Ma and Dundas (2009) found that school location did impact mathematics achievement, even when SES was included in the analysis. Primarily, the conclusions reflect a rural disadvantage in mathematics achievement. According to Young (1998), analysis of the 1996 WASES data showed the importance of both the SES and school location variables on mathematics achievement in Australia. Specifically, Young found the effect for SES to be weak, but positive. On the other hand, the effect for school location was statistically significant, with urban students achieving better than rural students. Thus, the study concluded that while rural students are disadvantaged in their achievement, the disadvantage was further influenced by average SES.

Like Young (1998), Webster and Fischer (2000) examined the effects of school location and SES on mathematics achievement in Australia. Analysis of the data from the TIMSS study for 161 schools and 12,852 thirteen year olds showed a significant effect associated with school location. With this study categorizing schools as either urban or rural, and defining SES by parental education and father's occupation, the results indicated that a) students in schools with higher average SES performed better in mathematics, and that b) there was a strong negative effect for students in rural schools. Thus, not only did Webster and Fisher find a disadvantage associated with lower average SES in the schools, but they also found a disadvantage connected to the school location.

As discussed previously, Hsieh (2002) examined urban, suburban, and rural schools for their influence on mathematics achievement, when studied alongside school SES. Based on the separate analyses of SES and school location, Hsieh inferred that school SES would have a greater impact on mathematics achievement than school location. In the combined analyses, Hsieh found that for all three school locations, the high-SES schools performed better than the middle-SES schools, which subsequently performed better than the low-SES groups. At the same time, the trend of better achievement for suburban schools, then urban schools, and finally rural schools remained the same. Thus, similar to Young (1998) and Webster and Fischer (2000), this study also found a significant school location effect alongside the expected SES effect.

According to Fan and Chen (1999), many studies, investigating the effects of both SES and school location, fail to differentiate between family SES and school SES. However, a recent study by Ma and Dundas (2009) addresses this issue by including both SES levels in an analysis of the 2000 PISA mathematics data for the United States. As detailed in a previous section, three student-level SES variables and their school-level counterparts were utilized in the study: father's SES and mean father's SES, mother's SES and mean mother's SES, and family SES and school SES. Furthermore, four school locations were included: rural area, town, city, and big city. When the student level SES was examined, all SES measures were statistically significant for the rural region and the town. On the contrary, none of the measures were significant for the big city, nor was the mother's SES significant for the city location. Concerning school-level SES, all three measures were significant for the city and big city, while school mean mother's SES was the only non-significant measure for the town and rural area locations. Finally, the models examining both student-level and school level-SES measures simultaneously indicated that both SES levels were significant for father's SES and family SES in the rural area, town, and city categories. This was not the case for mother's SES, or for any SES measure in the big city location. Consequently, Ma and Dundas concluded that both the manner in which SES is defined (i.e., by parent contribution) and the school location influences mathematics achievement.

Conclusion

Based on this literature review, two conclusions are evident for research that examines the effect of the combination of SES and school location on mathematics achievement. First, all of the studies conclude that SES is significant for mathematics achievement (Alspaugh, 1992; Fan & Chen, 1999; Hsieh, 2002; Ma & Dundas, 2009; Reeves, 2003; Reynolds, 1991; Webster & Fisher, 2000; Young, 1998). Second, in contrast, the results for school location are mixed. Specifically, of the eight studies reviewed, half indicate no effect from school location (Alspaugh, 1992; Fan & Chen, 1999, Reeves, 2003; Reynolds, 1991), while the rest support the hypothesis that school location does impact mathematics achievement (Hsieh, 2002; Ma & Dundas, 2009; Webster & Fisher, 2000; Young, 1998). Clearly, the results for both SES and school location tend to mirror the results from the individual studies on each variable, with SES almost universally significant and school location inconsistent. Thus, research on school location should incorporate SES in order to obtain a better picture of the impact on mathematics achievement. However, the question of whether or not to include school location in research primarily centered on SES is still valid. Nevertheless, unless school location is shown not to influence achievement, its inclusion into the research will only add to the research literature and to our understanding.

Impact on Mathematics Achievement

Thus far, this literature review has addressed one question: Has socioeconomic status and/or school location significantly impacted mathematics achievement in schools? As discussed above, most of the studies provide an adequate response to this question; however, neither this question nor the subsequent answers address the second topic included in my research. In order to establish a basis for my investigation into the extent of the impact of SES and school location on mathematics achievement, the remainder of this literature review will examine any research containing this element. Similar to previous sections, this final section also separates the studies into three groups based on the variables included in the analysis: SES, school location, and the combination of SES and school location.

Socioeconomic Status

Even with an overwhelming number of studies citing statistical differences in achievement due to SES, the degree of the socioeconomic impact on mathematics achievement cannot be inferred without first considering correlations, amount of variance, and effect size. Unfortunately, research in this area has become increasingly rare, with the majority of studies dating back to the 1980s. However, during this time, these studies helped to establish an empirical relationship between SES and academic achievement.

In one of the most well known studies on this topic, White (1982) investigated the correlations between SES and mathematics achievement through a meta-analysis of 143 studies. When all the studies were analyzed, an average correlation of 0.25 was found; however, major differences between the correlations of the student-level SES and school-level SES with mathematics achievement became apparent. For family SES, the average correlation with mathematics achievement was 0.20, while school SES indicated an average correlation of 0.70 (as cited in Reyes & Stanic, 1988). In short, White concluded that a) SES has a positive correlation with mathematics achievement, but that b) the strength of the relationship varies depending on the level of the SES variable (as cited in Yang, 2003). Specifically, Reyes and Stanic (1988) note that "SES appears to account for less than 10% of the variance in mathematics achievement when the student is the unit of analysis and considerably more when there is an aggregated unit of analysis" (p. 32).

Thus, even though these results support the belief that SES influences student achievement in mathematics, they also challenge the general belief that SES is strongly related to mathematics achievement. According to the meta-analysis, the relationship appears weak for family SES and strong for school SES (Kohr et al., 1989). Subsequent studies have agreed with these conclusions (Byrnes, 2003; Howie & Pietersen, 2001; Kohr et al., 1989; Okpala et al., 2001; Opdenakker & Van Damme, 2001; Winters, 2003). For family SES, Byrnes (2003) found a correlation of 0.33 between mathematics proficiency and the SES indicator parental education. Similarly, Howie and Pietersen (2001) determined that the correlation of mother's education and mathematics literacy was 0.34. However, they also found that another common SES indicator, possessions in the home, had a 0.60 correlation with mathematics literacy.

Like family SES, the correlations between the school-SES measure and the outcome variable for mathematics achievement closely resembles the conclusions reached by White (1982). According to Opdenakker and Van Damme (2001), the correlation between school mean mathematics achievement and school mean father's education was 0.66. However, unlike the above studies, negative correlations were found when the school-SES measure was the percentage of students on free or reduced lunches. Rather than the negative correlations contradicting White's conclusions, they actually provide additional support because of the definition of this measure. Both Okpala et al. (2001) and Winters (2003) found correlations consistent with the high value determined by White, -0.77 and -0.625, respectively.

Most of the results follow the general trend established by White's meta-analysis from 1982. However, it also appears that most of the correlations tend to be slightly higher for the family-SES measures and slightly lower for the school-SES measures, which may reflect either the difference in the date of the study or in the SES variable. Like these studies on correlations, Kohr et al. (1989) agreed with the conclusions of White concerning the amount of variance accounted for by SES, concluding that the variance component for student SES was small and generally less than 10%. Unfortunately, because the research on this topic is limited, most studies favor correlations over amount of variance or effect size. As a result, research using the latter two options is not as readily available beyond the study by Kohr et al.(1989). Thus, discussing the results concerning variance or effect size in a generalized manner is not an option for this literature review.

School Location

Similar to studies on the impact of SES, studies focusing on the impact of school location on mathematics achievement are very limited. However, unlike SES, school location lacks a major study with which to compare subsequent research. As a result, forming general conclusions based on the small number of studies might be difficult. Two studies, Howley and Gunn (2003) and Lee and McIntire (2000), evaluated the impact of school location by calculating the effect size or the change in the standard deviation units associated with the treatment or condition. While Howley and Gunn examined the differences in NAEP mathematics scores for the nation and the extreme rural areas, Lee and McIntire considered the differences between rural and nonrural schools.

Howley and Gunn (2003) found effect sizes for the 1982 data to be approximately –0.25, with the effect sizes for the 1978 to 1996 data even smaller. Because there were changes in the locale classification after 1996, the effect sizes from this grouping are not necessarily comparable. The addition of more categories for rural areas led to a range of effect sizes between 0.029 and 0.11. According to Cohen (1988), effect sizes are small if d = 0.2, medium if d = 0.5, and large if d = 0.8. Thus, essentially all of the effect sizes calculated in this study are small. Similarly, Lee and McIntire found the difference in rural and nonrural means translated to an effect size of 0.23. Based on the results from both studies, the impact from school location on mathematics achievement appears to be relatively small; however, without additional information, including results from correlations and variance, this conclusion is limited.

Socioeconomic Status and School Location

Research on the extent of the impact of the combination of SES and school location on mathematics achievement is also limited. Both Webster and Fisher (2000) and Alspaugh (1992) examined the strength of the effect through correlations; however, Webster and Fisher did not analyze the combined effect of both variables. Thus, the correlations are categorized by the respective variables. For each SES indicator, the correlations are as follows: mother's education (0.26), father's education (0.28), and father's occupation (0.26). For rural schools, the results indicated a 0.19 correlation with mathematics achievement. These correlations reflect the trend established by White (1982) concerning the student-level SES variables, as well as the conclusions from the previous section for school location. In short, the size of the impact of these variables on mathematics achievement is small.

Unlike the above study, Alspaugh (1992) did find correlations for the combination of SES and school location. For rural schools, the correlation between the percentage of students receiving free or reduced lunch and mathematics achievement was 0.036, while urban schools showed a correlation of -0.642. Because of the lack of studies on this topic, the difference, though extreme, between the rural and urban school-SES correlations does not demonstrate any specific pattern. However, the urban school and school-SES combination does appear to affirm White's conclusion for the degree of impact of school SES.

Like Alspaugh (1992), Ma and Dundas (2009) examined the impact of the combination of SES and school location on mathematics achievement. This study evaluated the impact by calculating both the percentage of the total variance accounted for and the effect size. Before the student-level SES and the school-level SES were combined in a model, the effect sizes were found for the SES and school location combinations. At the student level, the SES indicators included father's SES, mother's SES, and family SES. The results for each respective indicator by school location are as follows: rural region (21.64, 17.37, 23.89), town (29.74, 24.46, 35.82), city (31.32, 7.81, 27.00), and big city (10.16, 5.83, 2.64). For the school-level SES indicators, the results by school location are rural region (25.77, -2.49, 36.33), town (41.05, 13.12, 29.13), city (50.40, 57.76, 51.09), and big city (57.30, 58.29, 63.84). Based on Cohen's (1988) effect sizes, the student-level SES impact on mathematics achievement for each school location appears to be small to medium, with greater effect shown for the town and city locations. At the school level, SES has a much larger impact on the city and big city (medium to large). Because most researchers consider effect size greater than 0.5 as educationally significant (Fraenkel & Wallen, 1996 as cited in Hsieh, 2002), this study indicates that while school-level SES has a greater impact than student-level SES, the educationally significant findings do depend on the school location.

According to Ma and Dundas (2009), it appears that the size of the impact for SES and school location primarily reflect the SES variables. However, the school location also influenced the impact on mathematics achievement. In addition to the effect sizes calculated above, effect sizes were also calculated for the combined family SES and school-SES models, but only when both variables were found to be significant. As such, effect sizes were calculated for father's SES and family SES for the rural region, town, and city. The effect sizes were as follows: rural region (39.84, 51.61), town (54.93, 48.89), and city (68.35, 61.62). Even though most of the total effects calculated were fairly large, only the family SES for the rural region and city were deemed educationally significant. However, for father's SES, both the town and the city locations showed educationally significant effects. Ma and Dundas also included the percentage of the total variance accounted for by these SES and location groupings. Father's SES accounted for 19%, 29%, and 40% of total variance for the rural region, town, and city, respectively; while family SES accounted for 19%, 20%, and 41%. Thus, the results tend to follow the trends for school SES, but are also dependent on the school location with the more urban locations showing more of an impact on mathematics achievement. However, because there are few studies addressing this topic, these results only provide an interpretation rather than a generalization.

Summary

This review of literature has established the need for more research regarding equity in mathematics education within the school effectiveness framework. Because inequity with regards to both socioeconomic status and school location has been implied through the years, this literature review examined studies focusing on these variables with the hopes of determining the significance and size of any effect on mathematics achievement. With this purpose in mind, both socioeconomic status and school location were defined as relates to the existing literature. Research on SES was separated by the definition or measure utilized in the studies, as well as by student-level SES, school-level SES, or both. Similarly, school location was discussed in terms of the type of categorization used by researchers: rural vs. nonrural, rural vs. urban, and rural vs. suburban vs. urban. However, studies incorporating the combination of SES and school location were reviewed separately. While these sections focused on whether or not the effect of these variables was significant, the final portion of the review examined studies that addressed the degree of impact of these variables on mathematics.

The findings regarding the student level SES indicate that family SES is significant in most studies on mathematics achievement for both definitions used. When SES is defined as a composite of such factors as parental education, occupation, and educational resources, most of the studies almost unanimously support the belief that family SES has some relationship with mathematics achievement (Brown, 1991; Coleman et al., 1966; D'Agostino, 2000; Howie & Pietersen, 2001; Kohr et al., 1989; McCoy, 2005; Opdenakker et al., 2002; Papanastasiou, 2000/2002; Schreiber, 2002; Weglinsky, 1998). Also, all of the studies defining family SES by the student's eligibility to participate in the free or reduced lunch program showed a significant relationship with mathematics achievement (Goddard et al., 2001; Muijs & Reynolds, 2003; Rech & Stevens, 1996; Smees et al., 2005; Wang & Goldschmidt, 2003; Witthuhn, 1984).

While family SES appears to consistently impact students' scores on achievement tests in mathematics, the results for school SES are not as consistent. The literature review shows a greater effect on mathematics achievement when the variable used is the percentage of students eligible for free or reduced meals (D'Agostino, 1998; Hsieh, 2002;

Muijs & Reynolds, 2003; Okpala et al., 2001; Smees et al, 2005; Winters, 2003). However, not all the studies found the effect to be significant (Goddard et al., 2001). Similarly, when school SES was defined as an aggregate of parents' education, occupation, and other variables, the lack of influence was even more notable (Opdenakker & Van Damme, 2001). Even with these discrepancies in the results, the literature appears to generally support the assertion that both school and family SES are important to mathematics achievement.

Even though numerous studies examined SES in some manner, few studies analyzed the effect of SES on mathematics achievement by incorporating both family SES and school SES in the same model. While the results are mixed, some of the findings indicate that both variables remain significant when evaluated in this manner (Kohr et al., 1989; Yang, 2003). However, Goddard et al. (2001) could not conclude that school SES remained significant. Also, Ma and Dundas (2009) found that the concurrent significance of both levels of SES depended on (a) the type of SES and (b) the school location variable. Thus, the literature review found that more research must be done in this area to adequately understand the concurrent effect of both family and school SES on mathematics achievement.

Unlike the findings for SES, the literature on school location found many inconsistencies between definitions or comparisons and within each grouping. Essentially, the results show that a) rural students achieve better than their counterparts at other locations (Winter, 2003), that b) students at urban schools achieve better than their counterparts (Cox, 2000; Hsieh, 2002), and that c) there is no difference in achievement due to school location (Fan & Chen, 1999; Lee & McIntire, 2000; Young, 1998/2000).

Based on the above summary of results, no overwhelming conclusion can be made to support the contention that one type of location has a greater positive or negative effect on mathematics achievement.

Even though the research indicates very consistent results with reference to SES and inconsistent results for school location, there is very little literature that considers both variables. However, two conclusions are evident for research that examines the effect of the combination of SES and school location on mathematics achievement. First, all of the studies conclude that SES is significant for mathematics achievement (Alspaugh, 1992; Fan & Chen, 1999; Hsieh, 2002; Ma & Dundas, 2009; Reeves, 2003; Reynolds, 1991; Webster & Fisher, 2000; Young, 1998). Second, in contrast, the results for school location are mixed. Specifically, of the eight studies reviewed, half indicate no effect from school location (Alspaugh, 1992; Fan & Chen, 1999; Reeves, 2003; Reynolds, 1991), while the rest support the hypothesis that school location does impact mathematics achievement (Hsieh, 2002; Ma & Dundas, 2009; Webster & Fisher, 2000; Young, 1998).

The final element of this literature review was the degree of impact of SES, school location, or both on mathematics achievement. Unlike the above sections, this topic has not been the focus of many research studies; however, the conclusions are as follows. Essentially, family SES has a weak effect on mathematics achievement, while school SES has a strong effect (Byrnes, 2003; Okpala et al., 2001; Opdenakker & Van Damme, 2001; White, 1982; Winters, 2003). In contrast, both Howley and Gunn (2003) and Lee and McIntire (2000) found the impact from school location on mathematics achievement to be relatively small. Finally, when SES and school location are combined in the analysis, the results tend to follow the trends for SES, particularly school SES, but they are also dependent on the school location. According to the research, the more urban locations have more of an impact on mathematics achievement (Alspaugh, 1992; Ma & Dundas, 2009; Webster & Fisher, 2000).

In summary, previous evidence suggests that socioeconomic status, at both the school and student levels, is significant for mathematics achievement. On the other hand, the literature on school location demonstrates inconsistent results. When research combined the two variables, the results indicated that both variables influenced student's mathematics achievement to some degree, which was also reflected in the research on the size of the effect. Unfortunately, as this literature review shows, research on the combination of both family and school SES, as well as SES and school location, is not widespread. As a result, the following questions have been largely unanswered: Are students being dually penalized by having low-family SES and low-school SES?; Which school locations primarily influence the effect of SES on mathematics achievement?; How do various definitions for SES effect mathematics achievement?; And are the results to these questions generalizable to a larger population, such as the international community? This study attempts to fill these voids in the literature by addressing the questions raised from this literature review.

Chapter 3

Methodology

This study will examine the double jeopardy phenomenon of the four SES measures on mathematics achievement from two different angles. Because the hypothesis was that the phenomenon of double jeopardy in mathematics achievement might depend on school location, the design of the study first centered on separate categorizations of school location. The two angles used to examine this topic are based on the type of effect: absolute or relative. First, the absolute effect of double jeopardy will be determined for each school location in each of the G8 countries. Second, the relative effect of double jeopardy will be identified for the same groupings of students using family-background variables and school-context variables as controls.

For the analyses, similar models will be used to find both the absolute and relative effects for each school location in the G8 countries. Each model examining the absolute effects will contain only one student-level SES measure, as well as the corresponding school-level SES measure, along with the outcome variable, mathematics achievement. As such, there will be four models for each school location. Next, the issue of the relative effect of double jeopardy will be addressed through a two-step process, incorporating the control variables: (1) the student-background variables will be added to the absolute model, and then (2) the school-contextual variables will be added and the effect noted. Similar to the analysis of absolute effects, this process will occur four times for each school location, one for each SES measure. The statistical analyses are performed using hierarchical linear modeling (HLM) through the software HLM 6.04, while the data is prepared through SPSS.

This chapter consists of six parts: (a) Data, (b) Description of the Variables, (c) Statistical Rationale, (d) Statistical Procedure, (e) Treatment of Missing Data, and (f) Limitations of the Study. The information provided in each section describes the methodology for this study and demonstrates its relevancy to the research questions on double jeopardy.

Data

The data for this study came from the 2003 Programme for International Student Assessment (PISA), which was coordinated by the Organisation for Economic Cooperation and Development (OECD). PISA 2003 is the second of three cycles assessing students' level of knowledge and skills essential for full participation in society at the end of their mandatory education. As such, this database contains the results of standardized assessments in reading, mathematical, and scientific literacy, as well as a domain of problem-solving. Specifically, the 2003 cycle focuses on the mathematical literacy of 15-year-olds students from the 41 participating countries.

Data for the PISA 2003 database was collected in 2003 via assessment test, student questionnaire, and school questionnaire (provided to the school representative). The typical sample size for the assessment test ranges between 4,500 and 10,000 students in each country. Each student takes a pencil-and-paper test, lasting a total of two hours, with different students taking different combinations of test items. The test items, which are organized around passages describing real-life situations, include multiple choice, short answer, and extended response questions. The achievement measures are taken from the assessment test using item response theory, while the two questionnaires provide information on the students' family backgrounds, school context, school organization, and instruction. For more information on the sampling procedures and the test design see the *PISA 2003 Technical Report* and the *PISA 2003 Data Analysis Manual: SPSS Users*, published by the Organisation for Economic Co-operation and Development (OECD, 2005).

For this current study on the effect of student-level and school-level SES on mathematics achievement, the sample was limited to the G8 countries: Canada, France, Germany, Italy, Japan, the Russia Federation, the United Kingdom, and the United States. Furthermore, the data for each country was grouped into categories based on school location. As such, each country examined four different student samples (refer to Appendix B). Unfortunately, the data from France did not include any information derived from the school questionnaire; therefore, France lacks data on school location as well as on school-contextual variables. As a result, France cannot be included in this study. Future reference to the G8 countries in this study will address only Canada, Germany, Italy, Japan, the Russian Federation, the United Kingdom, and the United States. However, even with this limitation, the use of the 2003 PISA database was an appropriate choice for a study examining large national samples through secondary analysis, especially for the purpose of assessment of the mathematics performance among G8 countries with regards to SES and school location.

Description of the Variables

Variables included in the 2003 PISA study measure both students' family background and students' school experiences, as well as school composition, school organization, and instruction. While the school effectiveness paradigm emphasizes student-background characteristics, school context, and school processes, this current study focuses solely on those variables descriptive of family and school context. As such, variables falling under the umbrella of school processes or instruction are not included. This decision to concentrate on family background and school context reflects the current interest or status in research. Specifically, researchers are interested in the determination of relevant variables that are not perceived as being changeable by educators and/or legislators for the purpose of discovering configurations of variables that most impact achievement in schools. As such, this current study examines SES and school-location variables for their impact on mathematics achievement, while utilizing other family-background variables and school-contextual variables as controls. Both the outcome variable and the independent variables described in Chapter 1 are detailed in this section.

Mathematics achievement was the outcome measure for this study. It measures each student's mathematical literacy, which is defined as "an individual's capacity to identify and understand the role that mathematics plays in the world, to make well-founded judgments and to use and engage with mathematics in ways that meet the needs of that individual's life as a constructive, concerned and reflective citizen" (see *The PISA 2003 Assessment Framework*, OECD, 2003). Because different students take different combinations of test items, PISA provides five plausible values (PV1math to PV5math) for the mathematics achievement, as estimates of parameters of the student populations for each of the G8 countries. As such, these plausible values are better than individual scores in describing the performance of the targeted population.

For this study on the double jeopardy phenomenon, *socioeconomic status* is the main explanatory factor. Because SES has been measured in a variety of ways throughout the literature, this study examines four different measures for SES: father's SES, mother's SES, and two for family SES. All four measures have been included in the 2003 PISA data at the student level, in the form of indices. However, in order to obtain the SES data for each measure at the school level, the data was aggregated from the students' SES measures to form a socioeconomic composition at the school level. The subsequent school-level variables are the mean father's SES, mean mother's SES, mean family occupation SES, and mean combined family SES.

Three of the measures, father's SES (BFMJ), mother's SES (BMMJ), and family occupation SES (HISEI), were based on the occupational status of the parents. Father's SES and mother's SES were determined by the students' report of their parents' respective occupations and status of employment: full-time, part-time, out of work but looking for work, or "other". These answers were then coded according to the *International Standard Classification of Occupations* (ISCO 1988). The family occupation SES uses a combination of data from the father's SES and mother's SES; however, only the higher of the father or mother's occupation or the occupation of the only available parent are incorporated into this measure. Also, because this measure recodes the above indices according to the *PISA International Socio-Economic Index of Occupational Status*, it captures the attributes of occupations that convert the parents' education into income. For these indices, higher values indicate higher socioeconomic status.

The final SES measure included in this study is designated as combined family SES (ESCS). Unlike the family occupation SES, which focuses on parental occupation, this measure is an index of economic, social, and cultural status, which more closely parallels the typical components of SES in the literature: education, occupational status, and income. Specifically, this index is derived from the following three PISA variables: highest level of parental education, highest parental occupation (family occupation SES), and the number of home possessions.

School location, like socioeconomic status, is an important component of this study. As the research literature has shown, the impact of school location on mathematics achievement may be significant, even when paired with SES. Because of this, the study has been designed to examine the differential effectiveness of school location, with respect to the four SES measures. As a result, for each G8 country, the schools have been grouped according to their location prior to any analysis. PISA defines school location according to the population of the area surrounding the school. The following categories were used in the database: village (less than 3,000), small town (3,000 to about 15,000), town (15,000 to about 100,000), city (100,000 to about 1,000,000), large city (more than 1,000,000). Instead of using all five categories, the first two were combined into one rural region, in order to provide a larger number of schools for the analysis (refer to Appendix C for the percentages of schools in each location according to country). In addition, limiting the number of classifications to four- rural region, town, city, and metropolitan- allows more comparisons between these results and the results from other research.

Even with the focus of the study on socioeconomic status and school location, other student-level and school-level variables have been included in the analysis as control variables. As stated above, an interest in the effect of configurations of unalterable variables mandates the exclusion of school-process variables in this study. As such, only family and school-context variables have been included as control variables. At the student level, the variables are gender, immigration background, language spoken at home, and family structure. At the school level, the variables are proportion of girls, school size, school type, student-to-mathematics teacher ratio, proportion of mathematics teachers, and the proportion of mathematics teachers with a degree in mathematics. All of these variables are described below according to their definitions from PISA.

Gender is based on student reports from the student questionnaire. This dichotomous variable codes the responses as follows: female (1) and male (2). For the purpose of this study, the responses were recoded as female (0) and male (1).

Immigration background provides information on both the student and parents' country of birth. The index for immigration background (IMMIG) utilized by PISA differentiates between native students (where at least one parent was born in the country of the assessment), first-generation students (where both parents were born outside the country of assessment), and non-native students (where neither the parents nor the student were born in the country of the assessment). The categories are coded as 1, 2, and 3 respectively. For this study, the responses were recoded as native students (1), which combined both the native and first-generation students, and non-native students (0), which utilized the third category.

Language spoken at home is a dichotomous variable centering on the student's response to the question of whether the language spoken at home most of the time is the language of the assessment, another official national language, or another national dialect or language. An affirmative answer was coded as (0), and a negative response was coded as (1), which indicated a foreign language spoken at home.

Family structure is provided by self-reported information from the students concerning the individuals currently living with them in the same household. PISA recoded the responses into one of the following categories, in order to create an index of family structure: (1) a single parent family where the student lives with only one parent or guardian, (2) a nuclear family where the student lives with both parents, (3) a mixed family where the student lives with either one parent and one guardian or two guardians, or (4) all other responses. The categories were coded as 1, 2, 3, and 4 respectively. In addition, for this variable, non-responses were treated as missing data or coded as not applicable. For this study, family structure was recoded to indicate single parent families (1), while with nuclear and mixed families were combined and recoded as (0). The fourth category was treated as missing data.

School size is based on the report of enrollment in the schools from the PISA 2003 school questionnaire. The total enrollment is based on the sum of the number of girls and the boys provided by the school principal.

Proportion of girls in each school is also based on the enrollment data provided by the school principal. This index is calculated by dividing the number of girls at the school by the total number of students enrolled.

School type reflects both the designation of the school as public or private, and the agency or organization providing the funding or final authority over decisions. Three categories were used by PISA for this index: (1) public schools controlled and managed by a public education authority or agency; (2) government-dependent private schools controlled by a non-government organization or with a governing board not selected by a government agency, but receive more than 50% of their core funding from government agencies; and (3) government-independent private schools controlled by a non-government organization or with a governing board not selected by a government agency, and receive less than 50% of their core funding from government agencies. The categories were coded as 1, 2, and 3 respectively. This study recoded these categories into public schools (1 and 2 = 1) and private schools (3 =0).

Student-to-mathematics teacher ratio is calculated by dividing the number of students enrolled in the school (school size) by the total number of mathematics teachers.

Proportion of mathematics teachers is an index that reflects the ratio of the number of mathematics teachers to the total number of teachers in the school. This variable is calculated by dividing the number of mathematics teachers by the total number of teachers in the school.

Proportion of mathematics teachers with a degree in mathematics is an index obtained by dividing the number of mathematics teachers with this qualification by the total number of mathematics teachers in the school.

Along with these above variables, the student-level weight (W_FSTUWT) and the school-level weight (SCWEIGHT) for each G8 country were included in the respective models. The student weight is necessary in order to address the unequal representation of the full student population by the students in the final PISA sample. Because schools can participate in the PISA study if they have at least one 15-year-old student, it is difficult to define the school population. Therefore, the school weight must be used in the analysis since it has been adjusted for school non-response.

For the purpose of statistical analysis, most of the student and school variables discussed above (not including the weights) were either standardized or centered. Only school location was exempt from this treatment, as a result of the differential effectiveness design of the study. For each of the student-level SES measures and the corresponding school-level SES measures, the data was standardized. Standardizing each entry of a measure required the mean and the standard deviation. Once the data was standardized, the mean was zero and the standard deviation was one. The standardized measures were then ready for use in the analysis. All of the other variables, those used as controls (gender, immigration background, language spoken at home, family structure, proportion of girls, school size, school type, student-to-mathematics teacher ratio, etc…), were centered around the mean for each measure. By centering the variables, the international mean is used as the common reference; thus, allowing comparisons across the G8 countries.

Statistical Rationale

This study uses statistical procedures identified as hierarchical linear modeling (HLM) (see Raudenbush & Bryk, 2002). Hierarchical linear modeling is utilized for studies with hierarchical data structures, in which one set of observations are nested within another. Unlike previous statistical methods, HLM addresses the problems of aggregation bias, misestimated standard errors, and “units of analysis,” which can, at times, compromise the results or at least generate concerns for the analysis of nested data (Goddard, Tschannen-Moran & Hoy, 2001; Raudenbush & Bryk, 2002). According to Raudenbush and Bryk there are three general uses for hierarchical linear models:

(1) Improved estimation of individual effects;

(2) Modeling cross-level effects;

(3) Partitioning variance-covariance components.

Because educational research is often hierarchical in nature with students nested within schools, HLM would be appropriate for most studies in this area. The current research questions concerning the phenomenon of the double jeopardy of SES in mathematics achievement are no exception. Therefore, multilevel modeling, or hierarchical linear modeling, was chosen as the most appropriate methodology because it reflects both a nested structure and the need to model the cross-level effects of SES. Specifically, a two-level hierarchical linear model was used for the analysis, where the student is designated as the level-one unit and the school as the level-two unit. Thus, this method allows the relationships at one level to be considered without ignoring the variability associated with other levels in the data hierarchy (Raudenbush & Bryk, 2002).

With hierarchical linear models, each level of the nested structure is formally represented by a specific submodel. These submodels provide two types of information: (1) the relationships among variables within each level, and (2) the manner in which variables at one level affect relations at others (Raudenbush & Bryk, 2002). As such, these models have the capability to partition variance of a dependent variable into within- and between- group components (Goddard et al., 2001). Furthermore, the software used for this study, HLM 6.04, is also equipped to integrate the plausible values for students included by the 2003 PISA data (Raudenbush, Bryk, Cheong, & Congdon, 2004).

Statistical Procedures

The statistical analysis for this study consists of six stages: (1) preparation of the data for statistical analysis; (2) a general description of the hierarchical linear models used in the analyses; (3) analyses of the null models for each school location; (3) analyses of the absolute double jeopardy models; (4) analyses of the adjusted double jeopardy models, incorporating level-1 and level-2 control variables; and (5) the calculation of the proportion of variance explained in each model.

Preparation of Data

As described earlier in this chapter, this study separately analyzes the data for four school locations in each of the G8 countries, with the exception of France. Because the 2003 database does not separate the data in this way, the first step in the statistical procedures was to prepare the data by creating databases for each country using SPSS. Utilizing this program allowed the data to be isolated into separate databases according to the assigned country codes provided by PISA. During this process, the student-level and the school-level data for each country were prepared separately, until they could be combined in the final country database.

Specifically, the four SES measures (father's SES, mother's SES, family occupation SES, and combined family SES) were standardized at the student level using SPSS. Each entry of a particular measure was standardized using the international mean and the international standard deviation of that measure. Once the data was standardized, the mean was zero and the standard deviation was one. Next, the student-level SES measures were aggregated to the school level in each database. The subsequent school-level variables were named mean father's SES, mean mother's SES, mean family occupation SES, and mean combined family SES. In addition to standardizing the SES measures, each independent (control) variable was centered using SPSS. By centering the variable, the international mean was used as the common reference; this allowed for comparisons of the double jeopardy phenomenon across the G8 countries.

Once the variables were standardized and centered, the data from the student-level and school-level files were combined into one database for each country. Next, separate databases for each of the four school locations in each country were constructed through the previously described regrouping of the school locations. As such, a total of 28 databases were created, representing the rural region, town, city, and metropolitan locations for each country. The resulting databases contained the outcome variables (plausible values), the student- and school-level SES measures, the control variables at each level, and the school and student weights.

The next step in preparing the data for analysis was to create the mdm files for each of the designated school locations from each country, using HLM 6.04. Within each file, the settings included nesting within groups and the pair-wise deletion of data for each variable, which will be discussed further in the following section. Each mdm file included all of the independent variables, the school and student weights, and the plausible values. However, both the weights and the plausible values were primarily incorporated into the analyses, instead of during the creation of the mdm files.

Specifically, plausible value 1 (PV1) was designated as the outcome variable, while the other plausible values were incorporated through the estimation setting.

Statistical Models

Because one dimension of this study is to examine and compare the separate effects of each socioeconomic measure, each measure was considered in a separate model. Thus, for every country, each school location has a total of 9 models: (a) one null model; (b) four absolute double jeopardy models, one for each SES measure; and (c) four adjusted double jeopardy models, one for each SES measure, which incorporate both the level-1 and level-2 control variables.

The simple two-level form of the hierarchical model used in this analysis is as follows (see Raudenbush & Bryk, 2002):

Level 1 (student level): $Y_{ij} = \beta_{0j} + \beta_{1j} X_{ij} + r_{ij}$

Level 2 (school level): $\begin{array}{l} \beta_{0j} = \gamma_{00} + \gamma_{01} W_j + u_{0j}, \\ \beta_{1j} = \gamma_{10} + \gamma_{11} W_j + u_{1j} \end{array}$

The combined form of the model is:

$$Y_{ij} = \gamma_{00} + \gamma_{10} X_{ij} + \gamma_{01} W_j + \gamma_{11} X_{ij} W_j + u_{0j} + u_{1j} X_{ij} + r_{ij}$$

where - Y_{ij} is the outcome measure (e.g., mathematics achievement via plausible values)

X_{ij} is a level-1 predictor (e.g., student level father's, mother's, occupation-related family SES or combined family SES);

W_j is a level-2 predictor (e.g., one of the four school-SES measures);

r_{ij} is a level-1 random effect;

u_{oj}, u_{1j} are level-2 random effects;

$\gamma_{00}, \ldots, \gamma_{11}$ are level-2 coefficients (also called fixed effects).

Within this model, the intercept is treated as random, and the remaining coefficients are treated as fixed.

Null Models

In order to examine both the absolute and relative effect sizes of the double jeopardy phenomenon, the null models for each school location first had to be analyzed. In these models, only the plausible values for mathematics (Y_{ij}) are included. As such, the null models are of the following form:

Level 1 (student level): $Y_{ij} = \beta_{0j} + r_{ij}$

Level 2 (school level): $\beta_{0j} = \gamma_{00} + u_{0j}$

While these null models do not directly address the question of double jeopardy, each model does provide the information necessary for determining the effect size of both the absolute and adjusted double jeopardy models. Specifically, each null model provides the student- and school-level variance necessary for the calculation of the proportion of variance explained, which is described in further detail later in this chapter.

Absolute Double Jeopardy Models

The absolute double jeopardy models for each school location are of the same form as the general equation, wherein mathematics achievement (via plausible values) is the outcome variable and each pair of the corresponding level-1 SES and level-2 SES predictors are the only independent variables. As a result of the standardization of all of the SES measures, each of them was designated as uncentered in the subsequent models. One example of the absolute double jeopardy model measures the father's SES (BFMJ) and the mean father's SES (MFATHER) effects on mathematics (Y_{ij} - plausible values). This model is as follows:

Level 1 (student level): $Y_{ij} = \beta_{0j} + \beta_{1j}(BFMJ) + r_{ij}$

Level 2 (school level): $$\begin{aligned} \beta_{0j} &= \gamma_{00} + \gamma_{01}(MFATHER) + u_{0j}, \\ \beta_{1j} &= \gamma_{10} \end{aligned}$$

The other three pairs of SES measures are the mother's SES (BMMJ) and mean mother's SES (MMOTHER), family occupation SES (HISEI) and mean family occupation SES (MHISEI), and combined family SES (ESCS) and mean combined family SES (MESCS). Each of the remaining pairs of SES measures forms a double jeopardy model, the same for each school location and each country, with the exception of the data inputted for analysis.

Based on this two-level hierarchical absolute model, the mathematical definition for double jeopardy with the standardized SES at both levels is:

$$\gamma_{01} + \gamma_{10}.$$

In other words, double jeopardy is determined by the school-level SES impact and the student-level SES impact.

Adjusted Double Jeopardy Models

The second double jeopardy model analyzed for each SES measure, in each school location, for each country is similar to the above model, but it also incorporates level-1 and level-2 control variables described earlier in this chapter. Originally, all of the control variables were to be included in this model. Unfortunately, because of the small sample of schools- primarily in the metropolitan locations- the maximum number of school-level variables that could be included in the models varied. In order to address this issue, a procedure was developed to determine only the most important of these control variables for each individual model.

The new method considers first the student-level control variables for each model, and then the school-level control variables. Because the student sample sizes were large enough to accommodate all of the level-1 control variables, all of the variables were added to the model. Furthermore, each variable was designated as uncentered because each had been previously centered using SPSS. These variables are as follows: gender (GENDER), immigration background (IMMIG), language spoken at home (LANG), and family structure (FAMSTRUC). Once again, utilizing the father's SES measure, an example of the level-1 portion of the model is shown below:

$$\text{Level 1 (student level): } Y_{ij} = \beta_{0j} + \beta_{1j}(BFMJ) + \beta_{2j}(GENDER) + \beta_{3j}(IMMIG) + \beta_{4j}(LANG) + \beta_{5j}(FAMSTRUC) + r_{ij}$$

Unfortunately, each model using the Japanese data required some modification at this level. Specifically, three variables were excluded for certain school locations: immigration background, language spoken at home, and family structure. The variable for single parent families was not provided by Japan in the PISA data, so it could not be included in any model. Also, due to the low frequency of native students and foreign language spoken at home, the rural region excluded both variables; while the town, city, and metropolitan areas only excluded the immigration variable describing native and non-native students.

The next step of the procedure was to decide which of the level-2 control variables should be included in each adjusted double jeopardy model: school size (SCHLSIZE), proportion of girls (PCGIRLS), school type (SCHLTYPE), student-to-mathematics teacher ratio (SMRATIO), proportion of mathematics teachers (PROPMATH), and proportion of mathematics teachers with a degree in mathematics (PROPMATHDEG).

In order to limit the number of variables, only those significant ($p < 0.05$) were used in the model. However, if there were no significant variables, than the variable with the smallest p-value was retained. These variables were determined by the following steps: (1) each variable was tested separately in the model for significance, and then (2) all the significant variables were put back in the model, while the non-significant variables were removed one at a time according to the highest p-value. Similar to the level-1 control variables, each variable was designated as uncentered throughout this process because each had been previously centered using SPSS. This method produced school-level control variables for each adjusted double jeopardy model (refer to Appendix D for a complete listing of the variables for each model).

Once again, utilizing the father's SES measures, one example of the level-2 portion of the model for the rural region of the United States is shown below:

Level 2(school level):

$$\begin{aligned}
\beta_{0j} &= \gamma_{00} + \gamma_{01}(MFATHER) + \gamma_{02}(SCHLTYPE) \\
\beta_{1j} &= \gamma_{10} \\
\beta_{2j} &= \gamma_{20} \\
\beta_{3j} &= \gamma_{30} \\
\beta_{4j} &= \gamma_{40} \\
\beta_{5j} &= \gamma_{50}
\end{aligned}$$

Because each pair of SES measures has a corresponding model, for each school location, in each of the G8 countries, this study analyzes 112 of these double jeopardy models.

Calculation of the Proportion of Variance Explained

The final step in the statistical procedure was to calculate the proportion of variance explained by the two latter double jeopardy models. Although the hierarchical linear analysis of each double jeopardy model provides the statistical significance of the double jeopardy phenomenon on mathematics achievement, the proportion of variance explained shows the size of the double jeopardy effect on mathematics achievement. As such, each of the null models provides a baseline for comparisons with the two subsequent double jeopardy models: a) the absolute models, and b) the adjusted models with the level-1 and level-2 control variables. The proportion of variance explained was calculated according to the following formula:

$$\frac{\text{(variance in the null model – variance in a specific model)}}{\text{(variance in the null model)}}$$

By focusing on the three forms of the hierarchical linear model, this study examines both the absolute effects of the double jeopardy phenomenon on mathematics achievement, and the relative effects determined by the control variables. As such, this study provides a fairly comprehensive look at the double jeopardy phenomenon, given the goals and restrictions placed on it by the researcher. Thus, analyzing the 2003 PISA data from the G8 countries based on school location provides a unique opportunity to expand on a topic rarely found in the research literature.

Treatment of Missing Data

In any quantitative research study, missing data is inevitable. For the 2003 PISA study, the missing data reflects either incomplete data at the student level or the school level. Because the data was collected via a written achievement test and several questionnaires, both the dependent variable and the independent variables are potentially absent from the data set. Depending on the type of variable, deletion of the missing data occurs in two steps during the preparation of the data phase and the analysis phase of this study.

The first step in the process of treating the missing data addresses the absence of the dependent variable- mathematics achievement- and the school-level independent variables. Because the plausible values for mathematics achievement are essential for any analysis in this study, the students without these measures were deleted during the preparation of data phase. Specifically, students were selected as long as the school ID and all five of the plausible values (PV1MATH to PV5MATH) were included in the data. The data for all other students was deleted through SPSS during the creation of the databases for each country. Because of this, the amount of students omitted is not readily available.

At the school level, schools and the students within those schools were only selected if the data was not missing for the school locations and the level-2 control variables. Because this study analyzes school location differentially, any school that did not provide information on this variable was omitted during the creation of the school-level databases for each country using SPSS. In addition, the schools with information missing from the school-level independent variables were also be deleted, since HLM does not allow for missing variables at this level. As a result, the exact number of deletions are not readily available. Furthermore, because France lacked data for all variables at the school level, it was not included in the study.

Finally, data missing from the student-level independent variables was addressed through pair-wise deletion during the analysis. Pair-wise deletion was chosen because this process only removes the missing data concerning the variables currently included in the specific double jeopardy model. Thus, as many students as possible are retained in the sample without compromising the results of any given model (Ma & Dundas, 2009). However, as a result, the sample size actually used for any specific variable will be different from any other variable, and from the initial total sample size used for each school location.

Limitations of the Study

Secondary data analysis carries with it certain restrictions and limitations related to the research design and implementation of the original study. This current study is no exception. By utilizing the 2003 PISA data for mathematics achievement, both the definitions for school locations and for the SES measures are already established. Unfortunately, in some of the cases, the definitions provided do not reflect those definitions in the literature.

Specifically, the treatment of school location in the PISA study is unable to address the all of the diverse definitions for the various school locations found in the literature. Because of this, it is difficult to ascertain whether or not the results of the analyses on mathematics achievement are consistent with the previous research. Even though this study regroups the original five school-location categories into four locations more in line with the literature, the definitions for rural area, town, city, and metropolitan may not be comparable to earlier definitions. Unfortunately, according to Ma and Dundas (2009), questions of remoteness of the area, the type of economy, and cultural influences may also further make the groupings of school location incomparable. And because this study only adds control variables, such as home or family characteristics of the students and the school-contextual characteristics, these concerns are not clearly addressed in this study, even though school size, home language, and immigration background might fall along these lines.

The main concern in this study on the double jeopardy of SES on mathematics achievement is the manner in which SES is defined in the literature. While the first three SES measures taken from PISA (father's SES, mother's SES, and family occupation SES) do not have corresponding measures in the literature, combined family SES does seem to parallel the family SES definition commonly used in earlier studies. However, while this measure considers parental occupation, education, and income, it does not incorporate one common factor included in other composite indicators of family SES: home resources. As such, it is once again difficult to compare the results from these analyses with the results from other studies. Fortunately, most of the results on the effect of SES on mathematics achievement are fairly consistent, no matter the actual definition utilized in the study. Therefore, the diverse definitions of SES may not affect the consistency of the double jeopardy models; however, future studies should investigate the factors making up the SES measures in order to establish which ones actually influence the double jeopardy result (Ma & Dundas, 2009).

Based on these limitations, any generalizations made from the conclusions of this research study need to be carefully thought out and considered in relation to the definitions and research design. Nevertheless, both the data and the research design are adequate and even appropriate for a study on the effect of double jeopardy on mathematics achievement. Ideally, the results will provide a foundation for future research into this topic, as well as a further understanding of the effect of SES on mathematics achievement.

Chapter 4

Results

This chapter describes the results of the statistical analyses delineated in Chapter 3. As indicated in that chapter, the PISA database for France did not include any information about schools. As a result, France was excluded from this study. Consequently, the results of the statistical analyses pertain to the remaining seven G8 countries: Canada, Germany, Italy, Japan, the Russian Federation, the United Kingdom, and the United States.

Specifically, this chapter considers three major results for each of the G8 countries (excluding France): the results indicating which double jeopardy models show evidence of the double jeopardy phenomenon, the size of the double jeopardy effect reported in the form of the percentage of a standard deviation as a measure of effect size, and the performance (or aptness) of each model determined by the proportion of variance explained. The results are arranged according to country in the order presented earlier. Within each country, there are four sections that report (a) the partition of variance in the null model in each school location (i.e., rural regions, towns, cities, and metropolitan areas), (b) the significant double jeopardy effects, (c) the effect size of these double jeopardy phenomena, and (d) the proportion of variance explained by these double jeopardy models. Also, for each country, the descriptive statistics are provided for each SES measure, for each control variable (i.e., student-level and school-level variables), and for the outcome variable (i.e., mathematics achievement). For the economy of space, similar procedures used for all seven countries were detailed for Canada, but were not repeated for the remaining countries.

Canada

Using the SPSS statistical program, the descriptive statistics for the variables incorporated in this study were calculated for each country as a whole. For Canada, both the mean and the standard deviation of each measure are presented in Appendix E. With regards to mathematics achievement, Canada's mean was 532.00 with a standard deviation of 87.00. Given that the 2003 PISA mathematics achievement test has a mean of 500 and a standard deviation of 100, Canada had a mean higher than the international mean for the test.

In regards to the four SES variables incorporated into this study, the means and standard deviations were calculated at both the student level and school level. The first three SES measures (father's SES, mother's SES, and family occupation SES) are index variables based on the *PISA International Socio-Economic Index of Occupational Status*. The combined family SES is an internationally standardized variable, which is based on three PISA SES measures: highest level of parental education, highest level of parental occupation, and the number of home possessions. The mean for the father's SES at the student level was 43.35, with a standard deviation of 16.71; while the mean for the father's SES at the school level was 42.96, with a standard deviation of 8.06. The mean for the mother's SES at the student level was 46.06, with a standard deviation of 15.82; while the mean for the mother's SES at the school level was 45.65, with a standard deviation of 6.41. Similarly, the means and standard deviations for the family occupation

SES were 50.75 and 15.97, respectively, at the student level, and 50.26 and 7.32, respectively, at the school level. The means for the combined family SES at the student and school levels were 0.35 and 0.32, respectively, which indicates that the combined family SES in Canada was above the international average. Meanwhile the standard deviations for the combined family SES at the student and school levels were 0.85 and 0.43, respectively. In addition to mathematics achievement and the four SES measures, Appendix E contains additional descriptive statistics regarding the control variables that accompany the SES measures.

Null Models for Canada

As described in Chapter 3, the null model functions to partition variance in mathematics achievement into student and school components in each school location, which provides the bases for the later calculation of the percentage of the total variance accounted for by a specified model at the student and school levels. For the Canada data, null models indicated a similar pattern among all school locations: a higher proportion of the variance was at the student level than at the school level. Specifically, the percentage of variance in the rural region was 86.7% at the student level and 13.3% at the school level. In the town, the student level contained 73.0% of the variance, while 27.0% came from the school level. Similarly, 75.4% of the variance in the city location was attributed to the student level, while 24.6% was attributed to the school level. For the metropolitan location, the percentage of variation was 64.5% and 35.5% at the student level and the school level, respectively.

Based on the above partitions of variance in the Canada data, it is evident that the majority of variance in mathematics performance on the 2003 PISA mathematics assessment occurred among students; although the amount of the student-level variance differed between school locations. Also, even though most variance was at the student level, the variance attributable to the schools was statistically significant, at $\alpha = 0.05$, for all four school locations, indicating that mathematics achievement in Canada was significantly related to school-level factors.

Double Jeopardy Models for Canada

Double jeopardy measures a situation of dual penalties faced by socially disadvantaged students, who also attend socially disadvantaged schools: one penalty comes from having a low-SES family, and the other comes from attending a low-SES school. As such, the double jeopardy models contained both the student-level SES measure and its corresponding (aggregated) school-level SES measure. Hierarchical linear modeling (HLM) allowed the phenomenon of double jeopardy to be examined in terms of both the absolute effect (without the inclusion of student-level and school-level control variables) and the adjusted effect (with the inclusion of student-level and school-level control variables). Table 1 presents the results of the HLM analyses from both the absolute effect models and the adjusted effect models for Canada, which are displayed according to the four SES measures in each of the four school locations: rural region, town, city, and metropolitan area.

Results of the multilevel analysis indicated that, at $\alpha = 0.05$, double jeopardy was evident for Canada in both the absolute and adjusted double jeopardy models. However, within both types of these models, the results depended on both the school location and the SES measure. For the absolute effect models, double jeopardy was evident in each of the four school locations. In the rural region, town, and city locations, all four absolute effects- father's SES, mother's SES, family occupation SES, and combined family SES- were found to be statistically significant. However, in the metropolitan location, only the father's SES was statistically significant.

After controlling for the student-level and school-level variables in the adjusted double jeopardy models, only the father's SES kept statistically significant double jeopardy effects in the rural region. In contrast, all of the SES measures- father's SES, mother's SES, family occupation SES, and combined family SES- kept statistically significant double jeopardy effects in the town and city locations, signifying that the students were penalized twice, once at the student level and once at the school level, even after controlling for student-level and school-level variables. In the metropolitan location, two SES measures showed statistically significant double jeopardy effects after controlling for student-level and school-level control variables: father's SES and family occupation SES (new effects after the adjustment).

Effects of Double Jeopardy for Canada

The previous section described which of Canada's models showed evidence of double jeopardy, both before and after control variables were added. This section examined the size of the effects of double jeopardy pertaining to mathematics achievement. The absolute effects, which were examined first, are presented in Table 2.

Absolute double jeopardy effects. The double jeopardy effect can be interpreted as score points. Using one standard deviation (*SD*) difference at both the student level and the school level for each of the SES measures, the double jeopardy effect can also be interpreted as the percentage of a standard deviation (as a measure of effect size). Using both interpretations, the absolute double jeopardy effects for Canada are as follows.

On mathematics assessments, students whose father's SES was 1 *SD* higher outperformed students whose father's SES was 1 *SD* lower by 44.49 score points in rural regions, 73.79 score points in towns, 65.85 score points in cities, and 58.98 score points in metropolitan areas. Students whose mother's SES was 1 *SD* higher outperformed students whose mother's SES was 1 *SD* lower by 37.13, 95.30, and 84.34 score points, respectively for rural regions, towns, and cities. The absolute double jeopardy effects associated with the family occupation SES impacted the mathematics achievement of students in Canada by 41.47 score points in rural regions, 86.45 score points in towns, and 83.79 score points in cities. Meanwhile, the absolute double jeopardy effects associated with the combined family SES were 50.13, 100.33, and 93.99 score points, respectively for rural regions, towns, and cities.

Given that the 2003 PISA mathematics achievement has a mean of 500 and standard deviation of 100, the effect of double jeopardy on mathematics achievement can be converted into an effect size measure, which describes the magnitude of the effect in terms of the percentage of a standard deviation (*SD*). Utilizing this conversion, the absolute effects of double jeopardy for Canada are provided below.

The absolute double jeopardy effects associated with the father's SES were 45% of a *SD* for rural regions, 74% of a *SD* for towns, 66% of a *SD* for cities, and 59% of a

SD for metropolitan areas. The absolute double jeopardy effects associated with the mother's SES were 37%, 95%, and 84% of a *SD* for rural regions, towns, and cities, respectively. The percentages of *SD* associated with the absolute double jeopardy effects of the family occupation SES were 42%, 87%, and 84% for rural regions, towns, and cities, respectively. Meanwhile, the absolute double jeopardy effects of the combined family SES were 50% of a *SD* for rural regions, one full *SD* for towns, and 94% of a *SD* for cities.

According to Rosenthal and Rosnow (1984), effect sizes of more than 50% of a *SD* are classified as large, effect sizes between 30% and 50% are moderate, and effect sizes of less than 30% are small. Based on this classification, the majority of the absolute double jeopardy effects for Canada were large. Only the effects associated with the father's SES, mother's SES, and family occupation SES in the rural region were not considered large. However, even these effects were moderate. These results indicate that socially disadvantaged students in Canada were severely penalized by having a low-SES family while attending a low-SES school.

Adjusted double jeopardy effects. Similar to the absolute double jeopardy effects, the size of the effects of double jeopardy, pertaining to mathematics achievement, was also examined after adjustment for student-level and school-level variables. These results are presented in Table 3. The adjusted double jeopardy effects were compared to the absolute double jeopardy effects, in order to determine how critical the SES effects are; double jeopardy effects that remain, after student-level and school-level variables are adjusted, are considered stable and substantial.

As Table 3 indicates, the effects for the adjusted double jeopardy models were similar in magnitude to those of the absolute double jeopardy models. After controlling for student-level and school-level variables, students whose father's SES was 1 *SD* higher outperformed students whose father's SES was 1 *SD* lower in mathematics achievement by 41.63 score points in rural regions, 66.60 score points in towns, 60.56 score points in cities, and 76.15 score points in metropolitan areas. Students whose mother's SES was 1 *SD* higher outperformed students whose mother's SES was 1 *SD* lower by 85.57 and 80.13 score points, respectively for towns and cities. However, once student-level and school-level variables were controlled, the mother's SES no longer indicated statistically significant double jeopardy effects in rural regions.

After controlling for student-level and school-level variables, the adjusted double jeopardy effects of the family occupation SES were no longer statistically significant in rural regions; however, the adjusted double jeopardy effect for metropolitan areas was statistically significant. As such, the adjusted double jeopardy effects associated with the family occupation SES impacted the mathematics achievement of students in Canada by 79.72 score points in towns, 76.67 score points in cities, and 61.20 score points in metropolitan areas. Meanwhile, the adjusted double jeopardy effects associated with the combined family SES were 89.99 score points for towns and 85.24 score points for cities. After controlling for student-level and school-level variables, the combined family SES no longer indicated statistically significant double jeopardy effects in rural regions.

As indicated above, once student-level and school-level variables were controlled, three of the adjusted double jeopardy models- mother's SES, family occupation SES, and combined family SES- for the rural regions in Canada no longer indicated statistically significant double jeopardy effects. The disappearance of SES effects in these adjusted double jeopardy models signifies that SES effects were secondary to mathematics achievement in rural regions. However, for the models with statistically significant adjusted double jeopardy effects, the magnitude of double jeopardy effects indicated that SES measures were powerful indicators of mathematics achievement.

In terms of effect size, the adjusted double jeopardy effects associated with the father's SES were 42% of a *SD* for rural regions, 67% of a *SD* for towns, 61% of a *SD* for cities, and 76% of a *SD* for metropolitan areas. The adjusted double jeopardy effects associated with the mother's SES were 86% and 80% of a *SD* for towns and cities, respectively. The percentages of *SD* associated with the adjusted double jeopardy effects for the family occupation SES were 79%, 77%, and 61% respectively for towns, cities, and metropolitan areas. Meanwhile, the adjusted double jeopardy effects associated with the combined family SES were 90% of a *SD* for towns and 85% of a *SD* for cities.

Based on the classification system of Rosenthal and Rosnow (1984), most of the adjusted double jeopardy effects in Canada were large, greater than 50% of a *SD*. Similar to the absolute double jeopardy models, all the adjusted double jeopardy effects were large for the SES measures in the towns, cities, and metropolitan locations. Only the adjusted double jeopardy effect for the father's SES in the rural region did not fall into the large category; however, even this effect was considered moderate. Given these results, the severe penalty noted for the absolute double jeopardy models primarily remained the same, even after student-background and school-contextual variables were taken into account in the adjusted double jeopardy models. The only exceptions were the mother's SES, family occupation SES, and combined family SES for the rural regions, where these double jeopardy effects disappeared once the student-level and school-level variables were controlled. Overall, it can be concluded that socially disadvantaged students, coming from low-SES homes, and going to low-SES schools in Canada were seriously penalized on the 2003 PISA mathematics assessment in towns, cities, and metropolitan areas. However, as the results indicate, this penalty depended on both the SES measure and the school location.

Proportion of Variance for Canada

In order to determine the adequacy of the double jeopardy models for each of the four school locations included in the Canadian 2003 PISA data, the proportion of variance explained was calculated at both the student and school levels for each of the double jeopardy models. Similarly, the proportion of total variance explained (i.e., the combined variance explained at both the student and school levels) was also calculated for each double jeopardy model. Through the analyses, the student-level and school-level variance in the null models, and the subsequent absolute and adjusted double jeopardy models were obtained. Using the formula provided in Chapter 3, the proportion of variance explained was calculated for each of the double jeopardy models. The results of these calculations indicate how well each model performs; specifically, whether or not each model is a good fit to the 2003 PISA data for Canada.

The proportion of variance explained for the absolute double jeopardy models is listed in Table 2, but the focus of this section is on the proportion of variance explained for each of the adjusted double jeopardy models, which are the final products of this study (see Table 3). The adjusted double jeopardy models indicating no statistically significant double jeopardy effects were not discussed in this section. As such, the mother's SES and the combined family SES for the rural region and the metropolitan locations, as well as the family occupation SES for the rural region, were not discussed.

In the rural region, the proportion of variance explained in mathematics achievement was calculated for the model that contained father's SES at the student level and school mean father's SES at the school level. The percentage of variance explained was 34% at the school level and 7% at the student level. Overall, the father's SES explained 11% of the total variance.

In the second school location, the town, all four SES measures indicated an adjusted double jeopardy effect. For the father's SES, the percentage of variance explained in mathematics achievement was 64% at the school level and 2% at the student level. For the mother's SES, 63% and 3% of the variance was explained at the school level and the student level, respectively. The adjusted double jeopardy model for the family occupation SES explained 68% and 3% of the school-level and student-level variance. Similarly, the adjusted double jeopardy model for the combined family SES explained 67% of the variance at the school level and 5% of the variance at the student level. The calculations for the town location also included the percentage of total variance explained by each double jeopardy model: father's SES, 19%; mother's SES, 19%; family occupation SES, 21%; and combined family SES, 22%.

Similar to the town location, all four SES measures in the city location indicated an adjusted double jeopardy effect. For the father's SES, the percentage of variance explained in mathematics achievement was 82% at the school level and 10% at the student level. For the adjusted double jeopardy model associated with the mother's SES, the resulting percentages were 79% at the school level and 9% at the student level. The adjusted double jeopardy model for the family occupation SES explained 86% and 8% of the school-level and student-level variance, respectively. Similarly, the adjusted double jeopardy model for the combined family SES accounted for 84% of the variance at the school level and 10% of the variance at the student level. The percentage of total variance accounted for by the father's SES, mother's SES, family occupation SES, and combined family SES in cities was 27%, 27%, 27%, and 28%, respectively.

For the metropolitan location, only the adjusted double jeopardy models associated with father's SES and family occupation SES exhibited double jeopardy phenomena. For the father's SES, the percentage of variance explained in mathematics achievement was 71% at the school level and 6% at the student level. Meanwhile, the adjusted double jeopardy model for the family occupation SES accounted for 53% of the variance at the school level and 5% of the variance at the student level. The percentage of total variance accounted for by the double jeopardy models associated with the father's SES and family occupation SES in metropolitan areas was 29% and 22%, respectively.

The adequacy of the adjusted double jeopardy models can be determined by the overall percentage of variance explained in mathematics achievement. Gaur and Gaur (2006) stated that "while in natural science research it is not uncommon to get R square values [equivalent to the proportion of variance explained] as high as 0.99, a much lower value (0.10-0.20) of R square is acceptable in social science research" (p. 109). As such, all of the adjusted double jeopardy models for the Canada data accounted for a reasonable amount of the total variance, indicating that all of the adjusted double jeopardy models were adequate in explaining variation in mathematics achievement among students. In other words, these adjusted double jeopardy models were adequate fits to the data.

Effectiveness of the Double Jeopardy Models for Canada

One common phenomenon was evident for all the adjusted double jeopardy models generated from the Canada data: each model was much more effective at the school level than at the student level, when accounting for variance in mathematics achievement. In fact, at the school level, the majority of the adjusted double jeopardy models explained 60% to 86% of the variance, with the highest percentages occurring in the city location for all four SES measures: 79% to 86%. Only the adjusted double jeopardy model associated with the father's SES explained a relatively small percentage of variance at the school level, 34%. In short, all of the adjusted double jeopardy models were effective in accounting for variance in mathematics achievement at the school level.

In contrast, the adjusted double jeopardy models explained only 2% to 10% of the variance in mathematics achievement at the student level. The smallest percentage of variance accounted for at the student level occurred in the town location for all SES measures: 2% to 5%. The highest percentage of variance explained at the student level occurred in the city location: 8% to 10%. These results indicated that some of the adjusted double jeopardy models, primarily the father's SES, mother's SES, and family occupation SES in the town location, were limited in their ability to explain variance in mathematics achievement at the student level; although they were effective in accounting for variance in mathematics achievement at the school level.

The effectiveness of the adjusted double jeopardy models, in relation to the proportion of variance explained at the student level (very small) and school level (very large), is a common phenomenon in the research literature, not a unique occurrence to this study on double jeopardy. Because the formation of variance in academic achievement (e.g., mathematics) at the student level is very complicated, the vast majority of models with a selected number of student-level variables can only account for a very small amount of variance.

Although all of the SES measures adequately accounted for variance in mathematics achievement, two SES measures were more sensitive to double jeopardy: father's SES and family occupation SES. For the family occupation SES, three school locations- towns, cities, and metropolitan areas- exhibited adjusted double jeopardy effects, and a reasonable amount of the total variance was accounted for in each case: 21%, 27%, and 22%. More importantly, for the father's SES, all four school locations exhibited adjusted double jeopardy effects, and a reasonable amount of the total variance was accounted for in each case: 11%, 19%, 27%, and 29%. Because of the widespread nature of the double jeopardy phenomenon associated with the father's SES, this SES measure was the most sensitive of the four SES measures to double jeopardy in Canada.

Similar to the SES measures, adjusted double jeopardy effects also vary by school location. Two school locations exhibited adjusted double jeopardy effects, which accounted for a reasonable amount of the total variance for all four SES measures: towns- 19%, 19%, 21%, and 22%, respectively; and cities- 27%, 27%, 27%, and 28%, respectively. It is evident that the city location accounted for higher percentages of the total variance. Therefore, for Canada, the city location was the most sensitive of the four school locations to the double jeopardy phenomenon.

Germany

Similar to Canada, the descriptive statistics for Germany were calculated for SES variables, the student-level and school-level control variables, and the outcome variable. The mean and the standard deviation for each measure are presented in Appendix F. In regards to mathematics achievement, Germany's mean was 503.00, with a standard deviation of 103.00. Given that the 2003 PISA mathematics achievement test has a mean of 500 and a standard deviation of 100, Germany had a mean comparable to the international mean.

In regards to the four SES variables incorporated into this study, the means and standard deviations were calculated at both the student level and school level. The mean for the father's SES at the student level was 45.51, with a standard deviation of 17.09; while the mean for the father's SES at the school level was 44.66, with a standard deviation of 8.38. The mean for the mother's SES at the student level was 43.60, with a standard deviation of 15.37; while the mean for the mother's SES at the school level was 42.69, with a standard deviation of 7.09. Similarly, the means and standard deviations for the family occupation SES were 49.60 and 16.26, respectively, at the student level, and 48.83 and 8.44, respectively, at the school level. The means for the combined family SES at the student and school levels were 0.18 and 0.14, respectively, which indicates that the combined family SES in Germany was above international average. Meanwhile, the standard deviations for the combined family SES at the student and school levels were 0.99 and 0.58, respectively.

Null Models for Germany

For Germany, the null model for the rural region indicated that the student level contained 61.9% of the variance, while 38.1% of the variance was from the school level. In contrast, the percentage of variance in the town location was 43.2% at the student level and 56.8% at the school level. Meanwhile, 40.6% of the variance in the city location was attributed to the student level, while 59.5% was attributed to the school level. For the metropolitan location, the percentage of variance was 40.0% and 60.0% at the student level and the school level, respectively.

Based on the above partitions of variance, it is evident that the majority of variance in mathematics performance on the 2003 PISA mathematics assessment in Germany occurred among schools in the three larger school locations: towns, cities, and metropolitan areas. Only the rural region had a higher percentage of variance at the student level than at the school level. Even though the partitioning of variance in mathematics performance differed according to school location, the variance attributable to the schools was statistically significant, at $\alpha = 0.05$, for all four school locations, which indicates that mathematics achievement in Germany was significantly related to school-level factors.

Double Jeopardy Models for Germany

Table 4 presents the results of the HLM analyses of both the absolute effect models and the adjusted effect models for the Germany data. Results of the hierarchical linear modeling indicated that, at $\alpha = 0.05$, double jeopardy was evident for Germany in both the absolute and adjusted double jeopardy models. For the absolute effect models, double jeopardy was evident in each of the four school locations. Specifically, in both the rural region and the metropolitan location, absolute double jeopardy effects associated with the father's SES, family occupation SES, and combined family SES were found to be statistically significant. For towns, all of the absolute double jeopardy models (i.e., father's SES, mother's SES, family occupation SES, and combined family SES) demonstrated statistically significant double jeopardy effects. In contrast, in cities, only the absolute double jeopardy models associated with the father's SES and the combined family SES were statistically significant; thus, only these models showed evidence of double jeopardy.

After controlling for the student-level and school-level variables in the adjusted double jeopardy models, only the father's SES and the combined family SES kept statistically significant double jeopardy effects in the rural region. In contrast, all of the SES measures- father's SES, mother's SES, family occupation SES, and combined family SES- indicated statistically significant double jeopardy effects in the town location, signifying that the students were penalized twice: once at the student level and once at the school level. This was the case even after controlling for student-level and school-level variables. For cities, the adjusted double jeopardy models associated with the father's SES, family occupation SES, and combined family SES all demonstrated statistically significant double jeopardy effects, after controlling for student-level and school-level control variables. Similarly, all four SES measures in the metropolitan location showed statistically significant double jeopardy effects, after controlling for student-level and school-level control variables: father's SES, mother's SES, family occupation SES, and combined family SES.

Effects of Double Jeopardy for Germany

This section provides the size of both the absolute and adjusted effects of double jeopardy pertaining to mathematics achievement in Germany. Table 5 presents the size of the absolute effects of double jeopardy, while Table 6 presents the size of the adjusted effects of double jeopardy.

Absolute double jeopardy effects. For the Germany data, the absolute double jeopardy effects interpreted as score points are as follows: students whose father's SES was 1 *SD* higher outperformed students whose father's SES was 1 *SD* lower in mathematics achievement by 88.34 score points in rural regions, 122.75 score points in towns, 99.92 score points in cities, and 109.63 score points in metropolitan areas. In contrast to this widespread occurrence of double jeopardy associated with the father's SES, the only absolute double jeopardy effect associated with the mother's SES occurred in towns. In other words, students whose mother's SES was 1 *SD* higher outperformed students whose mother's SES was 1 *SD* lower by 141.69 score points in the town location. The absolute double jeopardy effects associated with the family occupation SES impacted the mathematics achievement of students in German schools by 123.50 score points in rural regions, 124.65 score points in towns, and 121.80 score points in metropolitan areas. Meanwhile, the absolute double jeopardy effects associated with the combined family SES were 142.22, 128.88, 99.67, and 107.24 score points, respectively, in rural regions, towns, cities, and metropolitan areas.

In terms of effect size, the absolute double jeopardy effects in Germany associated with the father's SES were 88% of a *SD* for rural regions, 123% of a *SD* for towns, 100% of a *SD* for cities, and 110% of a *SD* for metropolitan areas. The only absolute double jeopardy effect found for the mother's SES occurred in towns, measuring 142% of a *SD*. The percentages of *SD* associated with the absolute double jeopardy effects for the family occupation SES were 124%, 125%, and 122% for rural regions, towns, and metropolitan areas, respectively. Meanwhile, the effects of the absolute double jeopardy models associated with the combined family SES were 142% of a *SD* for rural regions, 129 % of a *SD* for towns, 100% of a *SD* for cities, and 107% of a *SD* for metropolitan areas.

All of the absolute double jeopardy effects for Germany were considered large. In fact, for the majority of the models, the magnitude of the effects were considerably larger than 50% of a *SD*. Specifically, all the effects, except for the father's SES in the rural region, were approximately 100% or more of a *SD*. These results indicate that socially disadvantaged students in Germany were severely penalized by having a low-SES family while attending a low-SES school.

Adjusted double jeopardy effects. The size of the effects of double jeopardy, pertaining to mathematics achievement in Germany, was also examined, after adjustment over student-level and school-level variables. These adjusted double jeopardy effects are presented in Table 6.

As Table 6 indicates, the effects for the adjusted double jeopardy models were similar in magnitude, but primarily smaller than those of the absolute double jeopardy models. After controlling for student-level and school-level variables, students whose father's SES was 1 *SD* higher outperformed students whose father's SES was 1 *SD* lower in mathematics achievement by 61.64 score points in rural regions, 111.13 score points in towns, 114.26 score points in cities, and 45.00 score points in metropolitan areas. The adjusted double jeopardy effects associated with the mother's SES impacted the mathematics achievement of students in Germany by 126.08 score points in towns and 92.48 score points in metropolitan areas. As these results indicate, an additional double jeopardy effect associated with metropolitan areas was found to be statistically significant for the mother's SES, after controlling for student-level and school-level variables.

After controlling for student-level and school-level variables, the adjusted double jeopardy effects for the family occupation SES indicated that an additional double jeopardy effect associated with cities was statistically significant. At the same time, once student-level and school-level variables were controlled, the family occupation SES no longer indicated statistically significant double jeopardy effects in rural regions. Thus, the adjusted double jeopardy effects were as follows: students whose family occupation SES was 1 *SD* higher outperformed students whose family occupation SES was 1 *SD* lower by 104.85, 91.19, and 84.15 score points, respectively, for the town, and city, and metropolitan locations. Meanwhile, the adjusted double jeopardy effects associated with the combined family SES were 118.46 score points for rural regions, 105.20 score points for towns, 92.08 score points for cities and 82.83 score points for metropolitan areas. For these models with statistically significant adjusted double jeopardy effects, the magnitude of the SES effects indicated that SES measures were powerful indicators of mathematics achievement.

In terms of effect size, the adjusted double jeopardy effects associated with the father's SES were 62% of a *SD* for rural regions, 111% of a *SD* for towns, 114% of a *SD* for cities, and 45% of a *SD* for metropolitan areas. The adjusted double jeopardy effects associated with the mother's SES were 126% and 93% of a *SD* for towns and metropolitan areas, respectively. The percentages of *SD* associated with the adjusted double jeopardy effects for the family occupation SES were 105%, 91%, and 84%, respectively, for towns, cities, and metropolitan areas. Meanwhile, the adjusted double jeopardy effects associated with the combined family SES were 119% of a *SD* for rural regions, 108% of a *SD* for towns, 92% of a *SD* for cities, and 83% of a *SD* for metropolitan areas.

It is evident that most of the adjusted double jeopardy effects in Germany were quite large, greater than 50% of a *SD*. Similar to the absolute double jeopardy models, all the adjusted double jeopardy effects were large for the SES measures in rural regions, towns, and cities. Only the double jeopardy effect for the father's SES in metropolitan areas did not fall into the large category; however, even this effect was considered moderate. Although the size of these double jeopardy effects was somewhat less in most cases, the severe penalty noted for the absolute double jeopardy models primarily remained the same, even after student-background and school-contextual variables were taken into account in the adjusted double jeopardy models. The only exception was the family occupation SES in rural regions, where the double jeopardy effect disappeared once the student-level and school-level variables were controlled. Overall, it can be concluded that socially disadvantaged students, coming from low-SES homes, and going to low-SES schools in Germany were severely penalized on the 2003 PISA mathematics assessment in all four school locations.

Proportion of Variance for Germany

In order to determine the adequacy of the double jeopardy models for each of the four school locations comprising the German 2003 PISA data, the proportion of variance explained was calculated at both the student and school levels for each of the double jeopardy models. Similarly, the proportion of total variance explained (i.e., the combined variance explained at both the student and school levels) was also calculated for each double jeopardy model. The results of these calculations indicate how well each model performs; specifically, whether or not each model is a good fit to the 2003 PISA data for Germany.

The proportion of variance explained in the absolute double jeopardy models is listed in Table 5, but the focus of this section is on the proportion of variance explained for each of the adjusted double jeopardy models, which are the final products of this study (see Table 6). The adjusted double jeopardy models that indicated no statistically significant double jeopardy effect were not discussed in this section. As such, the mother's SES and the family occupation SES for the rural region, as well as the mother's SES for the city location, were not discussed.

In the rural region, the proportion of variance explained in mathematics achievement was calculated for the models associated with the father's SES and combined family SES. For the father's SES, the percentage of variance explained was

64% at the school level and 6% at the student level. The adjusted double jeopardy model for the combined family SES explained 69% of the variance at the school level and 6% of the variance at the student level. The percentage of total variance accounted for by the adjusted double jeopardy models associated with the father's SES and the combined family SES was 29% and 30%, respectively.

In the town location, all four SES measures indicated an adjusted double jeopardy effect. For the father's SES, the percentage of variance explained in mathematics achievement was 76% at the school level and 15% at the student level. For the mother's SES, 82% and 11% of the variance was explained at the school level and the student level, respectively. The adjusted double jeopardy model for the family occupation SES explained 86% and 12% of the school-level and student-level variance. Meanwhile, the adjusted double jeopardy model for the combined family SES explained 89% of the variance at the school level and 12% of the variance at the student level. The calculations for the town location also included the percentage of total variance explained by each adjusted double jeopardy model: father's SES, 50%; mother's SES, 51%; family occupation SES, 54%; and combined family SES, 56%.

For cities, the adjusted double jeopardy models associated with the father's SES, family occupation SES, and combined family SES exhibited adjusted double jeopardy effects. For the father's SES, the percentage of variance explained in mathematics achievement was 81% at the school level and 16% at the student level. The adjusted double jeopardy model for the family occupation SES explained 88% and 16% of the school-level and student-level variance, respectively. Meanwhile, the adjusted double jeopardy model for the combined family SES accounted for 90% of the variance at the school level and 16% of the variance at the student level. The percentage of total variance accounted for by the father's SES, mother's SES, family occupation SES, and combined family SES in cities was 55%, 59%, and 60%, respectively.

Similar to the town location, all four SES measures in the metropolitan location indicated an adjusted double jeopardy effect. For the father's SES, the percentage of variance explained in mathematics achievement was 95% at the school level and 9% at the student level. For the mother's SES, 96% and 11% of the variance was explained at the school level and the student level, respectively. The adjusted double jeopardy model for the family occupation SES accounted for 97% of the variance at the school level and 10% of the variance at the student level. Meanwhile, the adjusted double jeopardy model for the combined family SES explained 97% of the variance at the school level and 12% of the variance at the student level. The percentage of total variance accounted for by the father's SES, mother's SES, family occupation SES, and combined family SES in metropolitan areas was 61%, 61%, 62%, and 63%, respectively.

All of the adjusted double jeopardy models for Germany accounted for a large amount of the total variance, indicating that all of the double jeopardy models were highly adequate in explaining variation in mathematics achievement among students. In other words, these double jeopardy models were adequate fits to the data.

Effectiveness of the Double Jeopardy Models for Germany

One common phenomenon was evident for all the adjusted double jeopardy models: each model was much more effective at the school level than at the student level in accounting for variance in mathematics achievement. In fact, at the school level, the majority of the adjusted double jeopardy models had 80% to 97% of the variance explained, with the highest percentages occurring in the metropolitan location for all four SES measures: 95% to 97%. Only the double jeopardy models in the rural region had variance explained at the school level, at 64% and 69% for the father's SES and combined family SES, respectively. Based on these results, all of the adjusted double jeopardy models were extremely effective in accounting for variance in mathematics achievement at the school level.

In contrast, the adjusted double jeopardy models explained 6% to 16% of the variance in mathematics achievement, at the student level. The smallest percentage of variance, accounted for at the student level, occurred in the rural region for the father's SES, 6%, and the combined family SES, 6%. The highest percentage of variance explained at the student level occurred in the city location for the three adjusted double jeopardy models: father's SES, 16%; family occupation SES, 16%; and combined family SES, 16%. These results indicated that although some of the adjusted double jeopardy models, primarily the father's SES and combined family SES in the rural region, were somewhat limited in their ability to explain variance in mathematics achievement at the student level, the majority of the double jeopardy models adequately explained variance in mathematics achievement at the student level.

Although all of the SES measures adequately accounted for variance in mathematics achievement, two of the SES measures were more sensitive to double jeopardy: father's SES and combined family SES. For both SES measures, all four school locations exhibited adjusted double jeopardy effects, and a reasonable amount of the total variance was accounted for in each case: father's SES- 29%, 50%, 55% and 61%; and combined family SES- 30%, 56%, 60%, and 63%. Because of the higher percentage of total variance explained associated with the combined family SES, this SES measure was the most sensitive of the four SES measures to double jeopardy for the Germany data set.

Similar to the SES measures, double jeopardy effects also vary by school location. Two school locations exhibited adjusted double jeopardy effects, which accounted for a reasonable amount of the total variance for all four SES measures: towns- 50%, 51%, 54%, and 56%; and metropolitan areas- 61%, 61%, 62%, and 63%. It is evident that the metropolitan location accounted for higher percentages of the total variance. Therefore, for Germany, the metropolitan location was the most sensitive of the four school locations to the double jeopardy phenomenon.

Italy

The mean and the standard deviation for each measure in the Italy data are presented in Appendix G. In regards to mathematics achievement, Italy's mean was 466.00, with a standard deviation of 96.00. Given that the 2003 PISA mathematics achievement test has a mean of 500 and a standard deviation of 100, Italy had a mean lower than the international mean.

In regards to the four SES variables incorporated into this study, the means and standard deviations were calculated at both the student level and school level. The mean for the father's SES at the student level was 43.34, with a standard deviation of 15.97; while the mean for the father's SES at the school level was 42.75, with a standard deviation of 7.65. The mean for the mother's SES at the student level was 43.14, with a standard deviation of 17.11; while the mean for the mother's SES at the school level was

41.94, with a standard deviation of 8.49. Meanwhile, the means and standard deviations for the family occupation SES were 47.54 and 16.29, respectively, at the student level and 46.59 and 8.32, respectively, at the school level. The means for the combined family SES at the student and school levels were -0.02 and -0.09, respectively, indicating that the combined family SES in Italy was below the international average. Meanwhile, the standard deviations for the combined family SES at the student and school levels were 0.97 and 0.58, respectively.

Null Models for Italy

For Italy, the null models indicated a similar pattern among all school locations: a higher proportion of the variance was at the school level than at the student level. Specifically, the percentage of variation in the rural region was 30.6% for the student level and 69.5% for the school level. In the town location, the student level accounted for 41.9% of the variance, while 58.1% came from the school level. Similarly, 35.6% of the variance in the city location was attributed to the student level, while 64.4% was attributed to the school level. For the metropolitan location, the percentage of variation was 16.3% and 83.7% at the student level and the school level, respectively.

Based on the above partitions of variance, the majority of variance in mathematics performance on the 2003 PISA mathematics assessment in Italy occurred among schools; although the amount of the school-level variance differed between the school locations. Even though most variance was at the school level, the variance attributable to the students was statistically significant, at $\alpha = 0.05$, for all four school locations, indicating that mathematics achievement in Italy was significantly related to student-level (and school-level) factors.

Double Jeopardy Models for Italy

Table 7 presents the results of the HLM analyses of both the absolute effect models and the adjusted effect models for Italy. For the absolute effect models, double jeopardy was evident in each of the four school locations. In the rural region, only the absolute double jeopardy effects associated with the family occupation SES and the combined family SES were statistically significant. In contrast, the absolute double jeopardy models associated with the mother's SES, family occupation SES, and combined family SES indicated double jeopardy effects in the town and the city locations. In the metropolitan location, only the absolute model associated with the mother's SES indicated double jeopardy effects; thus, only the mother's SES measure showed evidence of the double jeopardy phenomenon.

After controlling for the student-level and school-level variables in the adjusted double jeopardy models, the occurrence of double jeopardy in the rural region and in towns remained the same. Both the family occupation SES and the combined family SES demonstrated statistically significant double jeopardy effects in the rural region. Similarly, in the town location, the three SES measures- mother's SES, family occupation SES, and combined family SES- evincing double jeopardy in the absolute models also indicated statistically significant double jeopardy effects in the adjusted models. Meanwhile, only the adjusted double jeopardy effects associated with mother's SES and the combined family SES were statistically significant in the city location. In metropolitan areas, the adjusted double jeopardy effects associated with the mother's SES and the combined family SES were both statistically significant.

Effects of Double Jeopardy for Italy

This section provides the size of both the absolute and adjusted effects of double jeopardy, which pertain to mathematics achievement in Italy. Table 8 presents the size of the absolute effects of double jeopardy; while Table 9 presents the size of the adjusted effects of double jeopardy.

Absolute double jeopardy effects. For Italy, the absolute double jeopardy effects interpreted as score points are as follows: students whose mother's SES was 1 *SD* higher outperformed students whose mother's SES was 1 *SD* lower in mathematics achievement by 69.21 score points in towns, 62.18 score points in cities, and 133.44 score points in metropolitan areas. The absolute double jeopardy effects associated with the family occupation SES impacted the mathematics achievement of students in Italy by 140.43 score points in rural regions, 106.58 score points in towns, and 119.81 score points in cities. Meanwhile, the absolute double jeopardy effects associated with the combined family SES were 116.59, 114.46, and 115.18 score points, respectively, for rural regions, towns, and cities. Only father's SES exhibited no absolute double jeopardy effects for any of the school locations.

In terms of effect size, the absolute double jeopardy effects for Italy attributed to the mother's SES were 69% of a *SD* for towns, 62% of a *SD* for cities, and 133% of a *SD* for metropolitan areas. The percentages of *SD* associated with the absolute double jeopardy effects for the family occupation SES were 140%, 107%, and 120% for rural regions, towns, and cities, respectively. Meanwhile, the absolute double jeopardy effects attributed to the combined family SES were 117% of a *SD* for rural regions, 115 % of a *SD* for towns, and 115% of a *SD* for cities.

All the absolute double jeopardy effects for Italy were considered to be quite large. With the exception of the absolute double jeopardy effects for the mother's SES in towns and cities, the magnitude of these effects were considerably larger than 50% of a *SD*. In fact, all the remaining absolute double jeopardy effects were greater than one full *SD*. Based on these results, socially disadvantaged students in Italy were severely penalized by having a low-SES family, while attending a low-SES school.

Adjusted double jeopardy effects. The size of the effects of double jeopardy, pertaining to mathematics achievement, was also examined after adjustment for student-level and school-level variables. These adjusted double jeopardy effects are presented in Table 9.

As Table 9 indicates, the effects of the adjusted double jeopardy models were similar in magnitude, but primarily smaller than those of the absolute double jeopardy models. After controlling for student-level and school-level variables, none of the adjusted double jeopardy models associated with the father's SES was statistically significant, indicating a lack of double jeopardy effect. Similarly, the adjusted double jeopardy models associated with the mother's SES, family occupation SES, and combined family SES all mirrored the corresponding absolute models with only a few exceptions.

Students whose mother's SES was 1 *SD* higher outperformed students whose mother's SES was 1 *SD* lower in mathematics achievement by 67.77 score points in towns, 108.76 score points in cities, and 90.60 score points in metropolitan locations. Meanwhile, students whose family occupation SES was 1 *SD* higher outperformed students whose family occupation SES was 1 *SD* lower by 125.90 and 94.91 score points, respectively, for rural region and towns. However, once student-level and school-level variables were controlled, the family occupation SES no longer indicated statistically significant double jeopardy effects in cities. The adjusted double jeopardy effects associated with the combined family SES impacted the mathematics achievement of students in Italy by 103.79 score points in rural regions, 114.32 score points in towns, 109.38 score points in cities, and 117.41 score points in metropolitan areas. As these results indicate, an additional double jeopardy effect, in metropolitan areas, was found to be statistically significant for the combined family SES, after controlling for student-level and school-level variables.

To summarize, once student-level and school-level variables were controlled, the adjusted double jeopardy model for the family occupation SES in the city location no longer indicated statistically significant double jeopardy effects for Italy, which signifies that the family occupation SES effect was secondary to mathematics achievement. However, for the models with statistically significant adjusted double jeopardy effects, the SES measures were truly powerful indicators of mathematics achievement.

In terms of effect size, the adjusted double jeopardy effects for Italy attributed to the mother's SES were 68% of a *SD* for towns, 109% of a *SD* for cities, and 91% of a *SD* for metropolitan areas. The percentages of *SD* associated with the adjusted double jeopardy effects for the family occupation SES were 126% and 95%, respectively, for rural regions and towns. Finally, the adjusted double jeopardy effects attributed to the combined family SES were 104% of a *SD* for rural regions, 114% of a *SD* for towns, 109% of a *SD* for cities, and 117% of a *SD* for metropolitan areas.

All of the adjusted double jeopardy effects in Italy were large, at greater than 50% of a *SD*. Only the adjusted double jeopardy effects associated with the father's SES, at all locations, and the family occupation SES, in cities, were not statistically significant. Given these results, the severe penalty noted for the absolute double jeopardy models primarily remained the same, even after student-background and school-contextual variables were taken into account in the adjusted double jeopardy models. The only exception was the family occupation SES in cities, where the double jeopardy effect disappeared. Overall, it can be concluded that socially disadvantaged students, coming from low-SES homes, and going to low-SES schools, in all four school locations in Italy, were severely penalized on the 2003 PISA mathematics assessment.

Proportion of Variance for Italy

The proportion of variance explained for the absolute double jeopardy models is listed in Table 8; however, the focus of this section is on the proportion of variance explained for each of the adjusted double jeopardy models, which is detailed in Table 9. In the rural region, the adjusted double jeopardy models associated with the family occupation SES and the combined family SES indicated adjusted double jeopardy effects. For the family occupation SES, the percentage of variance explained in mathematics achievement was 59% at the school level and 2% at the student level. The adjusted double jeopardy model for the combined family SES explained 60% of the variance at the school level and 2% of the variance at the student level. Overall, the adjusted double jeopardy models for both the family occupation SES and the combined family SES explained 42% of the total variance.

For the town location, the adjusted double jeopardy models associated with the mother's SES, family occupation SES, and combined family SES all indicated adjusted double jeopardy effects. For the mother's SES, the percentage of variance explained in mathematics achievement was 61% at the school level and 6% at the student level. The adjusted double jeopardy model for the family occupation SES explained 51% and 5% of the school-level and student-level variance. Meanwhile, the adjusted double jeopardy model for the combined family SES explained 69% of the variance at the school level and 5% of the variance at the student level. The calculations for the town location also included the percentage of total variance explained by each adjusted double jeopardy model: mother's SES, 38%; family occupation SES, 32%; and combined family SES, 42%.

In cities, the adjusted double jeopardy models associated with the mother's SES and the combined family SES indicated adjusted double jeopardy effects. For the mother's SES, the percentage of variance explained in mathematics achievement was 64% at the school level and 7% at the student level. The adjusted double jeopardy model for the combined family SES explained 76% of the variance at the school level and 4% of the variance at the student level. The percentage of total variance accounted for by the mother's SES and combined family SES was 37% and 51%, respectively.

Similar to the city location, only the adjusted double jeopardy models associated with the mother's SES and the combined family SES indicated adjusted double jeopardy effects in the metropolitan location. For the mother's SES, the percentage of variance explained in mathematics achievement was 97% at the school level and 5% at the student level. The adjusted double jeopardy model for the combined family SES explained 98% of the variance at the school level and 3% of the variance at the student level. Overall, the percentage of total variance explained by the adjusted double jeopardy models for both the mother's SES and the combined family SES was 82%.

All of the adjusted double jeopardy models for Italy accounted for an important amount of the total variance, indicating that all of the double jeopardy models were adequate in explaining variation in mathematics achievement. In other words, these double jeopardy models were adequate fits to the data.

Effectiveness of the Double Jeopardy Models for Italy

One common phenomenon was evident for all the adjusted double jeopardy models: each model accounted for variance in mathematics achievement more effectively at the school level than at the student level. In fact, at the school level, the majority of the adjusted double jeopardy models had 50% to 76% of the variance explained, with the highest percentages occurring in the metropolitan location for the mother's SES, 97%, and the combined family SES, 98%. Only the adjusted double jeopardy models associated with the family occupation SES in the rural region and town locations had variance explained at the school level at 59% and 51%, respectively; while the mother's SES in the city location explained 54% of the variance at the school level. Based on these results, all of the adjusted double jeopardy models were effective in accounting for variance in mathematics achievement at the school level. In particular, the two models associated with the mother's SES and combined family SES in the metropolitan location were quite effective in accounting for variance in mathematics achievement at the school level.

In contrast, the double jeopardy models explained 2% to 7% of the variance in mathematics achievement at the student level. The smallest percentages of variance accounted for at the student level occurred in the rural region for the family occupation SES, 2%, and the combined family SES, 3%; and in the metropolitan location for the combined family SES, 3%. The highest percentage of variance explained at the student level occurred in the city and town locations for the mother's SES, 7% and 6%, respectively. The results indicated that all the adjusted double jeopardy models were limited in their ability to explain variance in mathematics achievement at the student level; although they were effective in accounting for variance in mathematics achievement at the school level.

Overall, all of the adjusted double jeopardy models for Italy were adequate in explaining variation in mathematics achievement. Although three of the SES measures adequately accounted for variance in mathematics achievement, one SES measure was more sensitive to double jeopardy: the combined family SES. For this SES measure, all four school locations in Italy exhibited adjusted double jeopardy effects, and a reasonable amount of the total variance was accounted for in each case: 42%, 42%, 51%, and 82%. In addition, a greater amount of the total variance was accounted for by adjusted double jeopardy models associated with the combined family SES than by the adjusted double jeopardy models associated with the mother's SES and the family occupation SES. As such, the combined family SES was the most sensitive of the four SES measures to double jeopardy in Italy.

Double jeopardy effects also vary by school location. In particular, one school location exhibited the most adjusted double jeopardy effects: the town location. In towns, three SES measures accounted for a reasonable amount of the total variance: mother's SES, 38%; family occupation SES, 32%; and combined family SES, 42%. Therefore, for Italy, the town location was the most sensitive of the four school locations to the double jeopardy phenomenon. However, the metropolitan location should not be overlooked, since both the mother's SES and the combined family SES accounted for the greatest amount of total variance explained, 82%, among all of the double jeopardy models for Italy.

Japan

The mean and the standard deviation for each measure in the Japan data are presented in Appendix H. In regards to mathematics achievement, Japan's mean was 534.00, with a standard deviation of 101.00. Given that the 2003 PISA mathematics achievement test has a mean of 500 and a standard deviation of 100, Japan had a mean higher than the international mean.

In regards to the four SES variables incorporated into this study, the means and standard deviations were calculated at both the student level and school level. The mean for the father's SES at the student level was 44.73, with a standard deviation of 14.08; while the mean for the father's SES at the school level was 44.21, with a standard deviation of 6.17. The mean for the mother's SES at the student level was 46.39, with a standard deviation of 14.90; while the mean for the mother's SES at the school level was 46.27, with a standard deviation of 5.27. Similarly, the means and standard deviations for the family occupation SES were 49.84 and 14.74, respectively, at the student level, and 49.55 and 5.73, respectively, at the school level. The means for the combined family SES at the student and school levels were -0.09 and -0.10, respectively, indicating that the combined family SES in Japan was below international average. Meanwhile, the standard deviations for the combined family SES at the student and school levels were 0.73 and 0.41, respectively.

Null Models for Japan

For Japan, the null model for the rural region indicated that the student level contained 56.1% of the variance, while 43.9% of the variance came from the school level. In the town location, the percentage of variance was 39.5% for the student level and 60.5% for the school level. Meanwhile, 44.3% of the variance in the city location was attributed to the student level; while 55.7% was attributed to the school level. For the metropolitan location, the percentage of variance was 43.1% and 56.9% at the student and the school levels, respectively.

Based on the above partitions of variance, the majority of variance in mathematics performance on the 2003 PISA mathematics assessment in Japan occurred among schools in the three larger school locations: towns, cities, and metropolitan areas. Only the rural region had a higher percentage of variance at the student level than at the school level. Even though the partitioning of variance in mathematics performance highlighted schools, the variance attributable to students was statistically significant, at $\alpha = 0.05$, for all four school locations, which indicates that mathematics achievement in Japan was significantly related to student-level (and school-level) factors.

Double Jeopardy Models for Japan

Table 10 presents the results of the HLM analyses from both the absolute effect models and the adjusted effect models for Japan. For the absolute effect models, double jeopardy was evident in only one school location: metropolitan areas. Three of the absolute double jeopardy effects- mother's SES, family occupation SES, and combined family SES- were statistically significant in metropolitan areas. In other words, none of the absolute double jeopardy effects associated with the father's SES, mother's SES, family occupation SES, and combined family SES were statistically significant in the three smallest school locations: rural regions, towns, and cities.

After controlling for the student-level and school-level variables in the adjusted double jeopardy models, the occurrence of double jeopardy in all four school locations remained the same. Only the adjusted double jeopardy effects associated with the mother's SES, family occupation SES, and combined family SES in the metropolitan location showed statistically significant double jeopardy effects. Thus, only in metropolitan areas did these three SES measures signify that socially disadvantaged students were penalized twice, once at the student level, by coming from a low-SES home, and once at the school level, by going to a low-SES school.

Effects of Double Jeopardy for Japan

This section provides the size of both the absolute and adjusted effects of double jeopardy pertaining to mathematics achievement in Japan. Table 11 presents the size of the absolute effects of double jeopardy; while Table 12 presents the size of the adjusted effects of double jeopardy.

Absolute double jeopardy effects. For Japan, the absolute double jeopardy effects interpreted as score points are as follows: students whose mother's SES was 1 *SD* higher outperformed students whose mother's SES was 1 *SD* lower in mathematics achievement by 188.59 score points in metropolitan areas. Meanwhile, in metropolitan areas, absolute double jeopardy effects associated with both the family occupation SES and the combined family SES impacted the mathematics achievement of students in Japan by 228.38 score points and 172.36 score points, respectively. Only the father's SES exhibited no absolute double jeopardy effects for any of the school locations.

In terms of effect size, the absolute double jeopardy effect attributed to the mother's SES in the metropolitan location was 189% of a *SD*. Meanwhile, the absolute double jeopardy effects attributed to the family occupation SES and the combined family SES in metropolitan areas were 228% of a *SD* and 172% of a *SD*, respectively.

It is evident that all the absolute double jeopardy effects for metropolitan areas in Japan were extremely large. Without exception, the magnitude of the absolute effects was considerably larger than 50% of a *SD*. In fact, all of the absolute double jeopardy effects were more than 150% of a *SD*. Based on these results, it can be concluded that, in Japan, socially disadvantaged students in metropolitan areas were severely penalized on the 2003 PISA mathematics assessment by coming from a low-SES family and going to a low-SES school.

Adjusted double jeopardy effects. The size of the effects of double jeopardy, pertaining to mathematics achievement, was also examined after adjustment for student-level and school-level variables. These adjusted double jeopardy effects are presented in Table 12.

As Table 12 indicates, the effects for the adjusted double jeopardy models were similar in magnitude to those of the absolute double jeopardy models. Specifically, the adjusted double jeopardy models for the father's SES in all four school locations, as well as the models for the mother's SES, the family occupation SES, and the combined family SES in rural regions, towns, and cities, indicated no double jeopardy effects. However, adjusted double jeopardy effects were evident in the metropolitan location.

Thus, after controlling for student-level and school-level variables, students whose mother's SES was 1 *SD* higher outperformed students whose mother's SES was 1 *SD* lower in mathematics achievement by 243.24 score points in metropolitan areas. Meanwhile, the adjusted double jeopardy effects associated with the family occupation SES and the combined family SES impacted the mathematics achievement of students in metropolitan areas of Japan by 254.95 and 178.32 score points, respectively. These models, with statistically significant adjusted double jeopardy effects, indicated that the three SES measures were truly powerful indicators of mathematics achievement.

In terms of effect size, the adjusted double jeopardy effect attributed to the mother's SES was 243% of a *SD* in metropolitan areas. The percentage of *SD* associated with the adjusted double jeopardy effect for the family occupation SES was 255% in the metropolitan location. Meanwhile, the adjusted double jeopardy effect attributed to the combined family SES was 178% of a *SD* in metropolitan locations.

All of these adjusted double jeopardy effects in Japan were extremely large, greater than 50% of a *SD*. In fact, all three effects in the metropolitan location have percentages of more than 175% of a *SD*. Thus, it can be concluded that socially disadvantaged students in metropolitan areas, who came from low-SES homes, and went to low-SES schools in Japan were severely penalized on the 2003 PISA mathematics assessment.

Proportion of Variance for Japan

The proportion of variance explained for the absolute double jeopardy models is listed in Table 11; however, the focus of this section is on the proportion of variance explained for each of the adjusted double jeopardy models, which is detailed in Table 12. In all four school locations, only three SES measures- mother's SES, family occupation SES, and combined family SES- in the metropolitan location exhibited the double jeopardy phenomenon. For the mother's SES, the percentage of variance explained in mathematics achievement was 65% at the school level and 11% at the student level. The adjusted double jeopardy model for the family occupation SES explained 79% and 10% of the school-level and student-level variance, respectively. Meanwhile, the adjusted double jeopardy model for the combined family SES explained 87% of the variance at the school level and 10% of the variance at the student level. The percentage of total variance accounted for by the mother's SES, family occupation SES, and combined family SES in metropolitan areas was 42%, 49%, and 54%, respectively.

All of the adjusted double jeopardy models for Japan accounted for an important amount of the total variance, 42%, 49%, and 54%, indicating that all of the double jeopardy models were adequate in explaining variation in mathematics achievement. In other words, these double jeopardy models were adequate fits to the data.

Effectiveness of the Double Jeopardy Models for Japan

One common phenomenon was evident for all the adjusted double jeopardy models: each model accounted for variance in mathematics achievement was much more effective at the school level than at the student level. For Japan, only the mother's SES, family occupation SES, and combined family SES indicated adjusted double jeopardy effects. For all three of these double jeopardy models, 65% to 87% of the variance was explained at the school level. In contrast, these double jeopardy models explained 10% to 11% of the variance at the student level. These results indicated that all of the adjusted double jeopardy models were quite effective in accounting for variance in mathematics achievement at both the school level and the student level.

Because only the metropolitan location showed evidence of double jeopardy in Japan, it was the only school location sensitive to double jeopardy. Moreover, the three SES measures in this location- mother's SES, family occupation SES, and combined family SES- that exhibited adjusted double jeopardy effects also accounted for a large amount of total variance explained: 42%, 49%, and 54%. Based on the amount of total variance explained for each SES measure, it is evident that the combined family SES was the most sensitive of the four SES measures to double jeopardy in Japan, as it accounted for a larger amount of total variance than either the mother's SES or the family occupation SES.

Russian Federation

The mean and the standard deviation for each measure in the data for the Russian Federation are presented in Appendix I. In regards to mathematics achievement, the mean for the Russian Federation was 468.00, with a standard deviation of 92.00. Given that the 2003 PISA mathematics achievement test has a mean of 500 and a standard deviation of 100, Russian Federation had a mean lower than the international mean.

In regards to the four SES variables incorporated into this study, the means and standard deviations were calculated at both the student level and school level. The mean for the father's SES at the student level was 42.51, with a standard deviation of 16.02; while the mean for the father's SES at the school level was 41.44, with a standard deviation of 6.99. The mean for the mother's SES at the student level was 46.46, with a standard deviation of 16.79; while the mean for the mother's SES at the school level was 45.84, with a standard deviation of 6.25. Similarly, the means and standard deviations for the family occupation SES were 50.22 and 16.02, respectively, at the student level, and 49.43 and 6.73, respectively, at the school level. The means for the combined family SES at the student and school levels were -0.06 and -0.13, respectively, indicating that the combined family SES in the Russian Federation was below the international average. Meanwhile, the standard deviations for the combined family SES at the student and school levels were 0.75 and 0.41, respectively.

Null Models for the Russian Federation

For the Russian Federation, the null models indicated a similar pattern among all school locations: a higher proportion of the variance was at the student level than at the school level. Specifically, the percentage of variance in the rural region was 72.4% for the student level and 27.6% for the school level. Similarly, 66.1% of the variance in the town location was attributed to the student level, while 33.9% was attributed to the school level. In the city location, the student level contained 75.7% of the variance; while 24.3% came from the school level. For the metropolitan location, the percentage of variance was 64.6% and 35.4% at the student level and the school level, respectively.

Based on the above partitions of variance, it is evident that the majority of variance in mathematics performance on the 2003 PISA mathematics assessment in the Russian Federation occurred among students. Even though most variance was at the student level, the variance attributable to the schools was statistically significant, at $\alpha = 0.05$, for all four school locations, which indicates that mathematics achievement in the Russian Federation was significantly related to school-level factors.

Double Jeopardy Models for the Russian Federation

Table 13 presents the results of the HLM analyses for both the absolute effect models and the adjusted effect models for the Russian Federation. For the absolute effect models, the town, city, and metropolitan locations exhibited double jeopardy effects. In towns, the absolute double jeopardy effects associated with the two family SES measures, family occupation SES and combined family SES, were statistically significant. In contrast, all of the absolute double jeopardy models- father's SES, mother's SES, family occupation SES, and combined family SES- indicated statistically significant double jeopardy effects in the city and metropolitan locations.

After controlling for the student-level and school-level variables in the adjusted double jeopardy models, the occurrence of double jeopardy in all four school locations remained the same. Specifically, the adjusted double jeopardy effects associated with the family occupation SES and the combined family SES remained statistically significant in the town location. Furthermore, all of the adjusted double jeopardy models- father's SES, mother's SES, family occupation SES, and combined family SES- indicated widespread adjusted double jeopardy effects, for both the city and metropolitan locations.

Effects of Double Jeopardy for the Russian Federation

This section provides the size of both the absolute and adjusted effects of double jeopardy pertaining to mathematics achievement in the Russian Federation. Table 14 presents the size of the absolute effects of double jeopardy, while Table 15 presents the size of the adjusted effects of double jeopardy.

Absolute double jeopardy effects. For the Russian Federation, the absolute double jeopardy effects interpreted as score points are as follows: students whose father's SES was 1 *SD* higher outperformed students whose father's SES was 1 *SD* lower in mathematics achievement by 81.88 score points in cities and 90.71 score points in metropolitan areas. Students whose mother's SES was 1 *SD* higher outperformed students whose mother's SES was 1 *SD* lower by 106.61 score points and 82.84 score points, respectively, in the city and metropolitan locations. The absolute double jeopardy effects associated with the family occupation SES impacted the mathematics achievement of students in the Russian Federation by 97.18 score points in towns, 118.87 score points in cities, and 86.18 score points in metropolitan areas. Meanwhile, the absolute double jeopardy effects associated with the combined family SES were 104.73, 137.07, and 123.37 score points, respectively, for towns, cities, and metropolitan areas. As these results indicate, no SES measure evinced an absolute double jeopardy effect for the rural region.

In terms of effect size, the absolute double jeopardy effects attributed to the father's SES were 82% of a *SD* for cities, and 91% of a *SD* for metropolitan areas. The absolute double jeopardy effects for the mother's SES were 107% and 83% of a *SD* for the city and metropolitan locations, respectively. The percentages of *SD* associated with the absolute double jeopardy effects for the family occupation SES were 97%, 119%, and 86% for towns, cities, and metropolitan areas, respectively. Meanwhile, the absolute double jeopardy effects attributed to the combined family SES were 105% of a *SD* for towns, 137% of a *SD* for cities, and 123% of a *SD* for metropolitan areas.

All of the absolute double jeopardy effects for the Russian Federation were considered large. In fact, for the majority of the models, the magnitude of the absolute double jeopardy effects was noticeably larger than 50% of a *SD*. These results indicate that socially disadvantaged students in towns, cities, and metropolitan areas in the Russian Federation were severely penalized by having a low-SES family and attending a low-SES school.

Adjusted double jeopardy effects. The size of the effects of double jeopardy, pertaining to mathematics achievement, was also examined after adjustment over student-level and school-level variables. These adjusted double jeopardy effects are presented in Table 15.

As Table 15 indicates, the adjusted double jeopardy effects associated with the father's SES and the mother's SES were primarily smaller in magnitude than the corresponding effects for the absolute double jeopardy models. After controlling for student-level and school-level variables, students whose father's SES was 1 *SD* higher outperformed students whose father's SES was 1 *SD* lower in mathematics achievement by 60.69 score points in cities, and 81.63 score points in metropolitan locations. Students whose mother's SES was 1 *SD* higher outperformed students whose mother's SES was 1 *SD* lower by 88.43 and 76.40 score points, respectively, for cities and metropolitan areas. The adjusted double jeopardy effects associated with the family occupation SES impacted the mathematics achievement of students in the Russian Federation by 99.25 score points in towns, 98.68 score points in cities, and 79.93 score points in metropolitan areas. Meanwhile, the adjusted double jeopardy effects associated with the combined family SES were 116.34 score points for towns, 112.99 score points for cities, and 130.18 score points for metropolitan areas. For these models with statistically significant adjusted double jeopardy effects, the magnitude of double jeopardy effects indicated that these SES measures were truly powerful indicators of mathematics achievement.

In terms of effect size, the adjusted double jeopardy effects attributed to the father's SES were 61% of a *SD* for cities, and 82% of a *SD* for metropolitan areas. The adjusted double jeopardy effects associated with the mother's SES were 88% and 76% of a *SD* for cities and metropolitan areas, respectively. The percentages of *SD* associated with the adjusted double jeopardy effects for the family occupation SES were 99%, 99%, and 80%, respectively, for towns, cities, and metropolitan areas. Meanwhile, the adjusted double jeopardy effects attributed to the combined family SES were 116% of a *SD* for towns, 113% of a *SD* for cities, and 130% of a *SD* for metropolitan areas.

All of the adjusted double jeopardy effects in the Russian Federation were categorized as large, greater than 50% of a *SD*. In fact, the majority of effects have percentages of more than 99% of a *SD*. Overall, it can be concluded that socially disadvantaged students coming from low-SES homes, and going to low-SES schools, in towns, cities, and metropolitan areas in the Russian Federation were severely penalized on the 2003 PISA mathematics assessment.

Proportion of Variance for the Russian Federation

The proportion of variance explained for the absolute double jeopardy models is listed in Table 14. However, the focus of this section is on the proportion of variance explained for each of the adjusted double jeopardy models, which is detailed in Table 15. Although no adjusted double jeopardy models in the rural region exhibited double jeopardy effects, the remaining three school locations did show evidence of double jeopardy effects. In towns, both the family occupation SES and the combined family SES indicated adjusted double jeopardy effects. For the family occupation SES, the percentage of variance explained in mathematics achievement was 57% at the school level and 5% at the student level. Meanwhile, the adjusted double jeopardy model for the combined family SES explained 60% of the variance at the school level and 6% of the variance at the student level. The percentage of total variance accounted for by the double jeopardy models associated with the family occupation SES and combined family SES was 22% and 24%, respectively.

In the city location, all four SES measures indicated an adjusted double jeopardy effect. For the father's SES, the percentage of variance explained in mathematics achievement was 61% at the school level and 6% at the student level. For the mother's SES, 79% and 3% of the variance was explained at the school level and the student level, respectively. The adjusted double jeopardy model for the family occupation SES explained 77% and 4% of the school-level and student-level variance. Meanwhile, the adjusted double jeopardy model for the combined family SES explained 69% of the variance at the school level and 4% of the variance at the student level. The percentage of total variance explained by each adjusted double jeopardy model in the city location was as follows: father's SES, 19%; mother's SES, 22%; family occupation SES, 22%; and combined family SES, 19%.

Similar to the city location, all four SES measures in the metropolitan location indicated an adjusted double jeopardy effect. For the father's SES, the percentage of variance explained in mathematics achievement was 49% at the school level and 5% at the student level. For the adjusted double jeopardy model associated with the mother's SES, this percentage was 34% at the school level and 10% at the student level. The adjusted double jeopardy model for the family occupation SES explained 43% and 8% of the school-level and student-level variance, respectively. Meanwhile, the adjusted double jeopardy model for the combined family SES accounted for 58% of the variance at the school level and 10% of the variance at the student level. The percentage of total variance accounted for by the father's SES, mother's SES, family occupation SES, and combined family SES in cities was 20%, 18%, 20%, and 27%, respectively.

All of the adjusted double jeopardy models of the Russian Federation data accounted for a reasonable amount of the total variance, indicating that all of the double jeopardy models were adequate in explaining variation in mathematics achievement. In other words, these double jeopardy models were adequate fits to the data.

Effectiveness of the Double Jeopardy Models for the Russian Federation

One common phenomenon was evident for all the adjusted double jeopardy models: each model was much more effective at the school level than at the student level in accounting for variance in mathematics achievement. In fact, at the school level, the majority of the adjusted double jeopardy models had 50% to 80% of variance explained, with the highest percentages occurring in the city location for all four SES measures: 61% to 79%. Only the adjusted double jeopardy models in the metropolitan location had lower variance, which was explained at the school level at 49%, 34%, 43%, and 58%, respectively, for the father's SES, mother's SES, family occupation SES, and combined family SES. As a result, all of the adjusted double jeopardy models were effective in accounting for variance in mathematics achievement at the school level, most notably the four models in the city location.

In contrast, the adjusted double jeopardy models explained 3% to 10% of the variance in mathematics achievement at the student level. The smallest percentages of variance accounted for at the student level occurred in the city location for the mother's SES, 3%, the family occupation SES, 4%, and the combined family SES, 4%. The highest percentage of variance explained at the student level occurred in the metropolitan location, 10%, for the two double jeopardy models: mother's SES and combined family

SES. These results indicated that most of the models were somewhat limited in their ability to explain variance in mathematics achievement at the student level.

As previously indicated, all of the adjusted double jeopardy models for the Russian Federation were adequate in explaining variation in mathematics achievement. Although all four SES measures adequately accounted for variance in mathematics achievement, two SES measures were more sensitive to double jeopardy: family occupation SES and combined family SES. For both SES measures, the three school locations exhibited adjusted double jeopardy effects, and a reasonable amount of the total variance was accounted for in each case: family occupation SES- 22%, 22%, and 20%; and combined family SES- 24%, 19%, and 27%. Because of the higher percentage of total variance explained associated with the combined family SES, this SES measure was the most sensitive of the four SES measures to double jeopardy in the Russian Federation.

Similar to the SES measures, double jeopardy effects also vary by school location. Two school locations exhibited adjusted double jeopardy effects that accounted for a reasonable amount of the total variance for all four SES measures: towns- 19%, 22%, 22%, and 19%; and metropolitan areas- 20%, 18%, 20%, and 27%. It is evident that the metropolitan location accounted for a greater percentage of the total variance. Therefore, for the Russian Federation, the metropolitan location was the most sensitive of the four school locations to the double jeopardy phenomenon.

United Kingdom

The mean and the standard deviation for each measure in the data set for the United Kingdom are presented in Appendix J. In contrast to the previous G8 countries, which present the mean mathematics achievement as a national mean and standard deviation, the OECD has opted to present these statistics for the United Kingdom in quartiles, according to the index of the quality of the schools' educational resources (OECD, 2004b). The mean achievement and standard deviation for each quartile are as follows: 499.00 (190.00), 497.00 (145.00), 502.00 (148.00), and 531.00 (145.00). Given that the 2003 PISA mathematics achievement test has a mean of 500 and a standard deviation of 100, the mean mathematics achievement in the United Kingdom for each quartile was near to the international mean; however, each standard deviation was much higher than the international standard deviation.

In regards to the four SES variables incorporated into this study, the means and standard deviations were calculated at both the student level and school level. The mean for the father's SES at the student level was 44.12, with a standard deviation of 17.37; while the mean for the father's SES at the school level was 43.44, with a standard deviation of 7.43. The mean for the mother's SES at the student level was 42.53, with a standard deviation of 16.48; while the mean for the mother's SES at the school level was 41.89, with a standard deviation of 6.45. Similarly, the means and standard deviations for the family occupation SES were 49.54 and 16.56, respectively, at the student level and 48.98 and 7.19, respectively, at the school level. The means for the combined family SES, at the student and school levels, were 0.09 and 0.06, respectively, which indicates that the combined family SES in the United Kingdom was above the international average. Meanwhile, the standard deviations for the combined family SES, at the student and school levels, were 0.90 and 0.45, respectively.

Null Models for the United Kingdom

For the United Kingdom, the null models indicated a similar pattern among all school locations: a higher proportion of the variance was at the student level than at the school level. Specifically, the percentage of variance in the rural region was 88.6% for the student level and 11.4% for the school level. Meanwhile, 59.1% of the variance in the town location was attributed to the student level, while 40.9% was attributed to the school level. In the city location, the student level contained 66.4% of the variance, while 33.6% came from the school level. Similarly, the percentage of variance in the metropolitan location was 68.2% and 31.8% at the student and the school levels, respectively.

Based on the above partitions of variance, the majority of variance in mathematics performance on the 2003 PISA mathematics assessment in the United Kingdom occurred among students. Even though most variance was at the student level, the variance attributable to the schools was statistically significant, at $\alpha = 0.05$, for all four school locations. This indicates that mathematics achievement in the United Kingdom was significantly related to school-level factors.

Double Jeopardy Models for the United Kingdom

Table 16 presents the results of the HLM analyses from both the absolute effect models and the adjusted effect models for the United Kingdom. At $\alpha = 0.05$, double jeopardy was evident for the United Kingdom in both the absolute and adjusted double jeopardy models. For the absolute effect models, all four school locations in the United Kingdom exhibited double jeopardy effects. Specifically, all of the absolute models- father's SES, mother's SES, family occupation SES, and combined family SES- indicated statistically significant double jeopardy effects in the rural region, town, and city locations. Meanwhile, only the absolute double jeopardy model associated with the combined family SES indicated statistically significant double jeopardy effects in metropolitan areas.

After controlling for the student-level and school-level variables in the adjusted double jeopardy models, the occurrence of double jeopardy in all four school locations remained the same. Specifically, all of the adjusted double jeopardy effects- father's SES, mother's SES, family occupation SES, and combined family SES- remained statistically significant in the rural region, town, and city locations. Similarly, only the adjusted double jeopardy model associated with the combined family SES was found to have statistically significant double jeopardy effects in metropolitan areas.

Effects of Double Jeopardy for the United Kingdom

This section provides the size of both the absolute and adjusted effects of double jeopardy pertaining to mathematics achievement in the United Kingdom. Table 17 presents the size of the absolute effects of double jeopardy, while Table 18 presents the size of the adjusted effects of double jeopardy.

Absolute double jeopardy effects. For the United Kingdom, the absolute double jeopardy effects interpreted as score points are as follows: students whose father's SES was 1 *SD* higher outperformed students whose father's SES was 1 *SD* lower in mathematics achievement by 48.37 score points in the rural region, 89.60 score points in towns, and 85.07 score points in cities. Students whose mother's SES was 1 *SD* higher outperformed students whose mother's SES was 1 *SD* lower by 52.16 score points, 113.21 score points, and 86.05 score points, respectively, for rural regions, towns, and cities. The absolute double jeopardy effects associated with the family occupation SES impacted the mathematics achievement of students in the United Kingdom by 56.39 score points in rural regions, 108.65 score points in towns, and 88.21 score points in cities. Meanwhile, the absolute double jeopardy effects associated with the combined family SES were evident in all four school locations: rural regions, 58.89 score points, towns, 107.92 score points, cities, 95.49 score points, and metropolitan areas, 102.34 score points.

In terms of effect sizes, the absolute double jeopardy effects attributed to the father's SES were 48% of a *SD* for rural regions, 90% of a *SD* for towns, and 85% of a *SD* for cities. Similarly, the magnitude of the absolute double jeopardy effects associated with the mother's SES were 52%, 113%, and 86% of a *SD* for the rural region, town, and city locations, respectively. The percentages of *SD* associated with the absolute double jeopardy effects for the family occupation SES were 56% for the rural region, 109% for towns, and 88% for cities. Meanwhile, the absolute double jeopardy effects attributed to the combined family SES were 59% of a *SD* for the rural region, 108% of a *SD* for towns, 96% of a *SD* for cities, and 102% of a *SD* for metropolitan areas.

Most of the absolute double jeopardy effects for the United Kingdom were considered large. In fact, all of the adjusted double jeopardy models in the town, city, and metropolitan locations have effects that were noticeably larger than 50% of a *SD*. Only the father's SES in the rural region showed a moderate effect, 48% of a *SD*. These results indicate that socially disadvantaged students in towns, cities, and metropolitan areas in the United Kingdom were severely penalized by having a low-SES family, while attending a low-SES school.

Adjusted double jeopardy effects. The size of the effects of double jeopardy, pertaining to mathematics achievement, was also examined after adjustment over student-level and school-level variables. These adjusted double jeopardy effects are presented in Table 18.

The effects for the majority of the adjusted double jeopardy models were similar in magnitude to, but primarily smaller than those of the absolute double jeopardy models. After controlling for student-level and school-level variables, students whose father's SES was 1 *SD* higher outperformed students in mathematics achievement whose father's SES was 1 *SD* lower by 51.28 score points in rural regions, 79.08 score points in towns, and 78.35 score points in cities. Students whose mother's SES was 1 *SD* higher outperformed students whose mother's SES was 1 *SD* lower by 51.71, 101.39, and 88.74 score points, respectively, for rural regions, towns, and cities. The adjusted double jeopardy effects associated with the family occupation SES impacted the mathematics achievement of students in the United Kingdom by 57.68 score points in rural regions, 99.23 score points in towns, and 87.08 score points in cities. Meanwhile, the adjusted double jeopardy effects associated with the combined family SES were evident in all four school locations: rural regions, 59.62 score points, towns, 99.16 score points, cities, 92.88 score points, and metropolitan areas, 85.00 score points. For these models with statistically significant adjusted double jeopardy effects, the magnitude of double jeopardy effects indicated that the SES measures were truly powerful indicators of mathematics achievement.

In terms of effect size, the adjusted double jeopardy effects attributed to the father's SES were 51% of a *SD* for rural regions, 79% of a *SD* for towns, and 78% of a *SD* for cities. The adjusted double jeopardy effects associated with the mother's SES were 52%, 101%, and 89% of a *SD* for rural regions, towns and cities, respectively. The percentages of *SD* associated with the adjusted double jeopardy effects for the family occupation SES were 58%, 99%, and 87%, respectively, for rural regions, towns, and cities. Meanwhile, the adjusted double jeopardy effects attributed to the combined family SES were 60% of a *SD* for rural regions, 99% of a *SD* for towns, 93% of a *SD* for cities, and 85% of a *SD* for metropolitan areas.

All of the adjusted double jeopardy effects for the United Kingdom were greater than 50% of a *SD*; thus, the effects were categorized as large. Furthermore, the penalties evident in the absolute double jeopardy models were retained in all the adjusted models after taking into account the student- and school-level control variables. However, in all but a few cases, the adjusted double jeopardy effects were smaller than the corresponding absolute double jeopardy effects. Even so, it can be concluded that socially disadvantaged students coming from low-SES homes, and going to low-SES schools, in all four school locations in the United Kingdom were seriously penalized on the 2003 PISA mathematics assessment.

Proportion of Variance for the United Kingdom

The proportion of variance explained for the absolute double jeopardy models is listed in Table 17; however, the focus of this section is on the proportion of variance explained for each of the adjusted double jeopardy models for the United Kingdom, which is detailed in Table 18. In the rural region, all four SES measures indicated an adjusted double jeopardy effect. For the father's SES, the percentage of variance explained in mathematics achievement was 58% at the school level and 11% at the student level. For the mother's SES, 60% and 9% of the variance was explained at the school-level and the student-level, respectively. The adjusted double jeopardy model for the family occupation SES explained 60% and 10% of the school and student level variance. Meanwhile, the adjusted double jeopardy model for the combined family SES explained 62% of the variance at the school level and 12% of the variance at the student level. Overall, the percentage of total variance accounted for by each SES measure was as follows: father's SES, 17%; mother's SES, 15%; family occupation SES, 16%; and combined family SES, 18%.

Similar to the rural region, all four SES measures in the town location indicated an adjusted double jeopardy effect. For the father's SES, the percentage of variance explained in mathematics achievement was 80% at the school level and 8% at the student level. For the adjusted double jeopardy model associated with the mother's SES, this percentage was 83% at the school level and 7% at the student level. The adjusted double jeopardy model for the family occupation SES explained 87% and 8% of the school-level and student-level variance. Meanwhile, the adjusted double jeopardy model for the combined family SES accounted for 90% of the variance at the school level and 11% of the variance at the student level. The percentage of total variance accounted for by the adjusted double jeopardy models associated with the father's SES, mother's SES, family occupation SES, and combined family SES was 37%, 38%, 40%, and 43%, respectively.

For the city location, all four SES measures indicated an adjusted double jeopardy effect. For the father's SES, the percentage of variance explained in mathematics achievement was 96% at the school level and 8% at the student level. For the mother's SES, 91% and 6% of the variance was explained at the school level and the student level, respectively. The adjusted double jeopardy model for the family occupation SES explained 96% and 8% of the school-level and student-level variance. Meanwhile, the adjusted double jeopardy model for the combined family SES explained 98% of the variance at the school level and 11% of the variance at the student level. Overall, the percentage of total variance accounted for by each SES measure was as follows: father's SES, 37%; mother's SES, 34%; family occupation SES, 37%; and combined family SES, 40%.

In the metropolitan location, the proportion of variance explained was only calculated for the adjusted double jeopardy model corresponding to the combined family SES, as all other models lacked the double jeopardy phenomenon. Thus, for metropolitan areas, the percentage of variance explained in mathematics achievement was 90% at the school level and 10% at the student level. Overall, 36% of the variance was explained for the combined family SES.

All of the adjusted double jeopardy models for the United Kingdom accounted for a reasonable amount of the total variance, indicating that all of the double jeopardy models were adequate in explaining variation in mathematics achievement. In other words, these double jeopardy models were adequate fits to the data.

Effectiveness of the Double Jeopardy Models for the United Kingdom

One common phenomenon was evident for all the adjusted double jeopardy models: each model was much more effective at the school level than at the student level in accounting for variance in mathematics achievement. In fact, at the school level, the majority of the adjusted double jeopardy models had 80% to 98% of the variance explained, with the highest percentages occurring in the city location for all four SES measures: father's SES, 96%; mother's SES, 91%; family occupation SES, 96%; and combined family SES, 98%. Only the adjusted double jeopardy models in the rural region had lower proportions of variance explained at the school level: 58% to 62%. Based on these results, all of the adjusted double jeopardy models were very effective in accounting for variance in mathematics achievement at the school level.

In contrast, the adjusted double jeopardy models explained 6% to 12% of the variance at the student level. The smallest percentage of variance accounted for at the student level occurred in the city location, 6% to 8%, while the highest percentage of variance explained at the student level occurred in the rural region, 9% to 12%. These results indicated that although the majority of the adjusted double jeopardy models adequately explained variance in mathematics achievement at the student level; some of the adjusted double jeopardy models were limited in their ability to explain variance in mathematics achievement at the student level.

Although all four SES measures adequately accounted for variance in mathematics achievement in the United Kingdom, one SES measure was more sensitive to double jeopardy: combined family SES. For this SES measure alone, all four school locations exhibited adjusted double jeopardy effects, which accounted for a reasonable amount of the total variance in each case: 18%, 43%, 40%, and 36%. Furthermore, all of the adjusted double jeopardy models associated with the combined family SES in the United Kingdom explained more variance than the adjusted double jeopardy models associated with the father's SES, mother's SES, and family occupation SES. In short, the combined family SES was the most sensitive of the four SES measures to double jeopardy in the United Kingdom, while the mother's SES appears to be the least sensitive.

Similar to the SES measures, double jeopardy effects also vary by school location. Three of the school locations exhibited adjusted double jeopardy effects for all four of the SES measures: rural regions, towns, and cities. Of these three locations, the town location accounted for the greatest amount of the total variance for all four SES measures: 37%, 38%, 40%, and 43%. However, the city location also accounted for a large percentage of the total variance: 37%, 34%, 37%, and 40%. Even so, it is evident that for the United Kingdom, the town location was the most sensitive of the four school locations to the double jeopardy phenomenon, while the metropolitan location was the least sensitive school location to double jeopardy.

United States

The mean and the standard deviation for each measure in the data set for the United States are presented in Appendix K. In regards to mathematics achievement, the mean for the United States was 483.00, with a standard deviation of 95.00. Given that the 2003 PISA mathematics achievement test has a mean of 500 and a standard deviation of 100, the United States had a mean lower than the international mean.

In regards to the four SES variables incorporated into this study, the means and standard deviations were calculated at both the student level and school level. The mean for the father's SES at the student level was 46.46, with a standard deviation of 18.58; while the mean for the father's SES at the school level was 45.83, with a standard deviation of 8.09. The mean for the mother's SES at the student level was 49.22, with a standard deviation of 15.44; while the mean for the mother's SES at the school level was 48.83, with a standard deviation of 5.69. The means and standard deviations for the family occupation SES were 54.19 and 16.38, respectively, at the student level, and 53.79 and 6.85, respectively, at the school level. The means for the combined family SES at the student and school levels were 0.28 and 0.25, respectively, indicating that the combined family SES in the United States was above the international average. Meanwhile, the standard deviations for the combined family SES at the student and school levels were 0.90 and 0.48, respectively.

Null Model for the United States

For the United States, the null models indicated a similar pattern among all school locations: there was a higher proportion of the variance at the student level than at the school level. The null model for the rural region indicated that the student level contained 88.6% of the variance, while 11.4% of the variance came from the school level. Meanwhile, 55.4% of the variance in the town location was attributed to the student level, while 44.6% of the variance was attributed to the school level. In the city location, the student level contained 57.5% of the variance, while 42.5% came from the school level. The percentage of variance in the metropolitan location was 65.3% and 34.7%, at the student level and the school level, respectively.

Based on the above partitions of variance, the majority of variance in mathematics performance on the 2003 PISA mathematics assessment in the United States occurred among students. Even though most variance was at the student level, the variance attributable to the schools was statistically significant, at $\alpha = 0.05$, for all four school locations, indicating that mathematics achievement in the United States was significantly related to school-level factors as well.

Double Jeopardy Models for the United States

Table 19 presents the results of the HLM analyses of both the absolute effect models and the adjusted effect models for the United States. For the absolute effect models, all four school locations exhibited double jeopardy effects. In the rural region, three absolute double jeopardy models- mother's SES, family occupation SES, and combined family SES- had statistically significant double jeopardy effects. Similarly, in the metropolitan location, three absolute double jeopardy effects- father's SES, family occupation SES, and combined family SES- were also found to be statistically significant. Only in the town location did all four absolute double jeopardy models-father's, mother's SES, family occupation SES, and combined family SES- indicate statistically significant double jeopardy effects. Meanwhile, only the absolute double jeopardy model associated with the combined family SES showed statistically significant double jeopardy effects in cities.

After controlling for the student-level and school-level variables in the adjusted double jeopardy models, double jeopardy was still evident in all four school locations. However, the adjusted double jeopardy models exhibited numerous differences in the double jeopardy results. Only the double jeopardy results in the town location remained the same: all four SES measures- father's SES, mother's SES, family occupation SES, and combined family SES- demonstrated statistically significant double jeopardy effects. In contrast, in the rural region, only the combined family SES indicated statistically significant double jeopardy effects. Furthermore, the adjusted double jeopardy model for the combined family SES was no longer statistically significant in the city location, after controlling for student-level and school-level variables; although the adjusted effect associated with the father's SES was statistically significant. In metropolitan areas, all of the adjusted double jeopardy models- father's SES, mother's SES, family occupation SES, and combined family SES- indicated double jeopardy effects. These results showed an additional SES measure, mother's SES, in the metropolitan location with statistical significance in the adjusted double jeopardy model.

Effects of Double Jeopardy for the United States

This section provides the size of both the absolute and adjusted effects of double jeopardy pertaining to mathematics achievement in the United States. Table 20 presents the size of the absolute effects of double jeopardy, while Table 21 presents the size of the adjusted effects of double jeopardy.

Absolute double jeopardy effects. For the United States, the absolute double jeopardy effects interpreted as score points are as follows: students whose father's SES was 1 *SD* higher outperformed students whose father's SES was 1 *SD* lower in mathematics achievement by 125.27 score points in towns and 112.92 score points in metropolitan areas. Meanwhile, students whose mother's SES was 1 *SD* higher outperformed students whose mother's SES was 1 *SD* lower by 73.78 score points and 164.72 score points, respectively, in rural regions and towns. The absolute double jeopardy effects associated with the family occupation SES impacted the mathematics achievement of students in the United States by 65.21 score points in rural regions, 151.94 score points in towns, and 155.51 score points in metropolitan areas. Absolute double jeopardy effects associated with the combined family SES were evident for all four school locations: rural regions, 71.31 score points, towns, 134.99 score points, cities, 122.50 score points, and metropolitan areas, 169.69 score points.

In terms of effect size, the absolute double jeopardy effects attributed to the father's SES were 125% of a *SD* for towns and 113% of a *SD* for metropolitan areas. The magnitude of the absolute double jeopardy effects associated with the mother's SES were 74% and 165% of a *SD* for the rural region and town locations, respectively. The percentages of *SD* associated with the family occupation SES were 65% for the rural region, 152% for towns, and 156% for metropolitan areas. Meanwhile, the absolute double jeopardy effects attributed to the combined family SES were 71% of a *SD* for the rural region, 135% of a *SD* for towns, 123% of a *SD* for cities, and 170% of a *SD* for metropolitan areas.

All of the absolute double jeopardy effects for the United States were considered large. In fact, all of the absolute double jeopardy models in the town, city, and metropolitan locations have effects that were much larger than 50% of a *SD*. Specifically, all of these effect sizes were over one full *SD*. In contrast, all of the effects in the rural region- mother's SES, family occupation SES, and combined family SES- were much smaller than those in the other three school locations: 74%, 65%, and 71% of a *SD*, respectively. Even so, these absolute double jeopardy effects also fell into the large category. As a result, it is evident that, in every school location, socially disadvantaged students in the United States were severely penalized by having a low-SES family and attending a low-SES school.

Adjusted double jeopardy effects. The size of the effects of double jeopardy, pertaining to mathematics achievement, was also examined after adjustment for student-level and school-level variables. These adjusted double jeopardy effects are presented in Table 21.

As Table 21 indicates, the effects for the majority of the adjusted double jeopardy models were similar, but they were somewhat smaller in magnitude to than those of the absolute double jeopardy models. After controlling for student-level and school-level variables, students whose father's SES was 1 *SD* higher outperformed students whose father's SES was 1 *SD* lower in mathematics achievement by 97.07 score points in towns, 35.49 score points for cities, and 107.08 score points for metropolitan areas. As these results indicate, an additional double jeopardy effect in the city location was statistically significant for the father's SES, after controlling for student-level and school-level variables. In contrast, after controlling for student-level and school-level variables, the mother's SES no longer indicated statistically significant double jeopardy effects in rural regions; however, the adjusted double jeopardy effect for metropolitan areas was statistically significant. As such, adjusted double jeopardy effects associated with the mother's SES impacted the mathematics achievement of students in the United States by 160.36 score points in towns and 83.00 score points in metropolitan areas.

Students whose family occupation SES was 1 *SD* higher outperformed students whose family occupation SES was 1 *SD* lower by 115.88 and 103.00 score points, respectively, for the town and metropolitan locations. However, after controlling for student-level and school-level variables, the family occupation SES no longer indicated statistically significant double jeopardy effects in rural regions. Similarly, the combined family SES no longer indicated statistically significant double jeopardy effects in cities after controlling for student-level and school-level variables. The adjusted double jeopardy effects associated with the combined family SES were 87.49 score points for rural regions, 126.23 score points for towns, and 118.63 score points for metropolitan areas. For the models with statistically significant adjusted double jeopardy effects, the magnitude of double jeopardy effects indicated that the SES measures were truly powerful indicators of mathematics achievement.

In terms of effect size, the adjusted double jeopardy effects attributed to the father's SES were 97% of a *SD* for towns, 36% of a *SD* for cities, and 107% of a *SD* for metropolitan areas. The adjusted double jeopardy effects associated with the mother's SES were 160% and 83% of a *SD* for towns and metropolitan areas, respectively. The percentages of *SD* associated with the double jeopardy effects for the family occupation SES were 116% and 103% respectively for towns and metropolitan locations. Meanwhile, the adjusted double jeopardy effects attributed to the combined family SES were 88% of a *SD* for rural regions, 126% of a *SD* for towns, and 119% of a *SD* for metropolitan areas.

It is evident that most of the adjusted double jeopardy effects in the United States were large, greater than 50% of a *SD*. Only the adjusted double jeopardy effect for the father's SES in the city location did not fall into the large category; however, even this effect was considered moderate at 36% of a *SD*. In fact, the majority of the adjusted double jeopardy models have effects sizes over one *SD*, while only the combined family SES in the rural region, 88% of a *SD*, father's SES in the town location, 97% of a *SD*, and mother's SES in the metropolitan location, 83% of a *SD*, had effect sizes of less than one *SD*.

Given these results, the severe penalty noted for the absolute double jeopardy models primarily remained the same, even after student-background and school-contextual variables were taken into account in the adjusted double jeopardy models. The only exceptions noted were the mother's SES and family occupation SES in rural regions, as well as the combined family SES in cities, where these adjusted double jeopardy effects disappeared. Overall, it can be concluded that socially disadvantaged students, coming from low-SES homes, and going to low-SES schools in rural regions, towns, and metropolitan areas in the United States were severely penalized on the 2003 PISA mathematics assessment.

Proportion of Variance for the United States

The proportion of variance explained for the absolute double jeopardy models is listed in Table 20; however, the focus of this section is on the proportion of variance explained for each of the adjusted double jeopardy models, which is detailed in Table 21. In the rural region, the proportion of variance explained in mathematics achievement was only calculated for the adjusted double jeopardy model associated with the combined family SES because all other models lacked the double jeopardy phenomenon. The percentage of variance explained for this adjusted double jeopardy model was 81% at the school level and 12% at the student level. Overall, 20% of the total variance was explained for the combined family SES.

In towns, all four SES measures indicated an adjusted double jeopardy effect. For the father's SES, the percentage of variance explained in mathematics achievement was 87% at the school level and 7% at the student level. For the mother's SES, 90% and 3% of the variance was explained at the school level and the student level, respectively. The adjusted double jeopardy model for the family occupation SES explained 85% and 5% of the school-level and student-level variance. Meanwhile, the adjusted double jeopardy model for the combined family SES explained 92% of the variance at the school level and 6% of the variance at the student level. The percentage of total variance explained by each adjusted double jeopardy model for the town location was 43%, 42%, 41%, and 45%, respectively, for the father's SES, mother's SES, family occupation SES, and combined family SES.

Similar to the rural region, only one adjusted double jeopardy model exhibited the double jeopardy phenomenon in the city location: the father's SES. For the father's SES, the percentage of variance explained in mathematics achievement was 90% at the school level and 5% at the student level. The percentage of total variance accounted for by the father's SES was 41%.

In the metropolitan location, all four SES measures indicated an adjusted double jeopardy effect. For the father's SES, the percentage of variance explained in mathematics achievement was 97% at the school level and 11% at the student level. For the adjusted double jeopardy model associated with the mother's SES, this percentage was 99% at the school level and 12% at the student level. The adjusted double jeopardy model for the family occupation SES explained 99% and 8% of the school-level and student-level variance. Meanwhile, the adjusted double jeopardy model for the combined family SES accounted for 99% of the variance at the school level and 16% of the variance at the student level. The percentage of total variance accounted for by the father's SES, mother's SES, family occupation SES, and combined family SES was 41%, 43%, 40%, and 48%, respectively.

All of the adjusted double jeopardy models for the United States accounted for a reasonable amount of the total variance, indicating that all of the double jeopardy models were adequate in explaining variation in mathematics achievement. In other words, these double jeopardy models were adequate fits to the data.

Effectiveness of the Double Jeopardy Models for the United States

One common phenomenon was evident for all the adjusted double jeopardy models: each model was much more effective at the school level than at the student level in accounting for variance in mathematics achievement. In fact, at the school level, all of the adjusted double jeopardy models had 81% to 99% of the variance explained; the highest percentages occurring in the metropolitan location for all four SES measures: father's SES, 97%; mother's SES, 99%; family occupation SES, 99%; and combined family SES, 99%. Only the adjusted double jeopardy model in the rural region had a lower proportion of variance explained at the school level at 81% for the combined family SES. Based on these results, all of the adjusted double jeopardy models were quite effective in accounting for variance in mathematics achievement at the school level.

In contrast, the adjusted double jeopardy models explained 3% to 16% of the variance at the student level. The smallest percentage of variance accounted for at the student level occurred in the town location, 3% to 7%; while the highest percentage of variance explained at the student level occurred in the metropolitan location, 8% to 16%. These results indicated that although the majority of the adjusted double jeopardy models were somewhat limited in their ability to explain variance in mathematics achievement at the student level, some of the adjusted double jeopardy models, specifically the combined family SES in the rural region, and the father's SES, mother's SES, and combined family SES in metropolitan areas, adequately explained variance in mathematics achievement at the student level, 11% to 16%.

Although all four SES measures adequately accounted for variance in mathematics achievement in the United States, two SES measures were more sensitive to double jeopardy: father's SES and combined family SES. For both of these SES measures, three school locations exhibited adjusted double jeopardy effects, and a reasonable amount of the total variance was accounted for in each case. For the father's SES, adjusted double jeopardy effects were evident in the town, city, and metropolitan locations, accounting for 43%, 41%, and 41% of the total variance explained, respectively. For the combined family SES, adjusted double jeopardy effects were evident in the rural region, town, and metropolitan locations, accounting for 20%, 45%, and 48% of the total variance explained, respectively. Although very similar in their sensitivity to double jeopardy, overall, the father's SES was the most sensitive of the four SES measures to the double jeopardy phenomenon in the United States.

Similar to the SES measures, double jeopardy effects also vary by school location. Two of the school locations exhibited adjusted double jeopardy effects for all four of the SES measures: towns and metropolitan areas. Of these two locations, the metropolitan location accounted for the greatest amount of the total variance for all four SES measures: 41%, 43%, 40%, and 48%; although the town location also accounted for a large percentage of the total variance for all four SES measures: 43%, 42%, 41%, and 45%. Thus, it is evident that the metropolitan location was the most sensitive of the four school locations to the double jeopardy phenomenon in the United States; while the rural region was the least sensitive school location, accounting for only 20% of the total variance for the combined family SES.

Table 1

Double Jeopardy Effects of Socioeconomic Status of Students and Schools on Mathematics Achievement in Canada

	Absolute		Adjusted	
	Effect	SE	Effect	SE
Rural Region				
Father's SES	17.27*	1.82	16.17*	1.91
Mean Father's SES	27.22*	7.95	25.46*	7.97
Mother's SES	13.53*	1.75	13.15*	1.76
Mean Mother's SES	23.60*	9.59	14.35	9.36
Family Occupation SES	17.90*	1.48	17.04*	1.62
Mean Family Occupation SES	23.57*	8.34	15.25	9.48
Combined Family SES	27.05*	1.88	25.96*	1.93
Mean Combined Family SES	23.08*	9.30	14.09	9.83
Town				
Father's SES	12.82*	3.64	12.09*	3.54
Mean Father's SES	60.97*	17.17	54.51*	17.04
Mother's SES	13.86*	2.79	13.20*	2.88
Mean Mother's SES	81.44*	23.26	72.37*	19.47
Family Occupation SES	17.56*	2.99	16.47*	3.10
Mean Family Occupation SES	68.89*	15.32	63.25*	13.82

Table 1 (continued).

Combined Family SES	29.03*	3.23	28.89*	3.28
Mean Combined Family SES	71.30*	21.23	61.10*	16.68
City				
Father's SES	11.35*	2.13	11.00*	2.30
Mean Father's SES	54.50*	8.18	49.56*	6.36
Mother's SES	13.50*	2.67	12.69*	2.90
Mean Mother's SES	70.84*	10.56	67.44*	9.63
Family Occupation SES	14.95*	2.79	13.22*	3.04
Mean Family Occupation SES	68.84*	8.22	63.45*	7.16
Combined Family SES	23.37*	3.67	23.10*	4.01
Mean Combined Family SES	70.62*	8.43	62.14*	8.04
Metropolitan				
Father's SES	13.10*	3.85	13.70*	4.39
Mean Father's SES	45.88*	20.65	62.45*	12.83
Mother's SES	11.41*	4.55	11.67*	4.89
Mean Mother's SES	17.99	29.57	17.38	24.09
Family Occupation SES	15.50*	4.82	16.23*	4.92

Table 1 (continued).

Mean Family Occupation SES	24.21	24.28	44.97*	16.38
Combined Family SES	26.59*	5.71	28.58*	5.91
Mean Combined Family SES	22.16	26.53	31.30	18.74

* $p < 0.05$.

Table 2

Absolute Effect: Double Jeopardy of Socioeconomic Status to Mathematics Achievement for Socially Disadvantaged Students Attending Socially Disadvantaged Schools in Canada

	Double Jeopardy			Variance Explained		
	Family	School	Total	Student Level	School Level	Total
Rural Region						
Father's Socioeconomic Status (SES)	17.27	27.22	44.49	0.05	0.24	0.08
Mother's SES	13.53	23.60	37.13	0.03	0.19	0.06
Family Occupation SES	17.90	23.57	41.47	0.05	0.25	0.07
Combined Family SES	27.05	23.08	50.13	0.06	0.31	0.09
Town						
Father's SES	12.82	60.97	73.79	0.01	0.58	0.16
Mother's SES	13.86	81.44	95.30	0.01	0.48	0.13
Family Occupation SES	17.56	68.89	86.45	0.02	0.56	0.17
Combined Family SES	29.03	71.30	100.33	0.04	0.50	0.17

Table 2 (continued).

City						
Father’s SES	11.35	54.50	65.85	0.06	0.65	0.20
Mother’s SES	13.50	70.84	84.34	0.06	0.63	0.20
Family Occupation SES	14.95	68.84	83.79	0.04	0.73	0.21
Combined Family SES	23.37	70.62	93.99	0.05	0.74	0.22
Metropolitan						
Father’s SES	13.10	45.88	58.98	0.03	0.26	0.11

Note. All estimates are statistically significant at $\alpha = 0.05$.

Table 3

Adjusted Effect: Double Jeopardy of Socioeconomic Status to Mathematics Achievement for Socially Disadvantaged Students Attending Socially Disadvantaged Schools in Canada

	Double Jeopardy			Variance Explained		
	Family	School	Total	Student Level	School Level	Total
Rural Region						
Father's Socioeconomic Status (SES)	16.17	25.46	41.63	0.07	0.34	0.11
Town						
Father's SES	12.09	54.51	66.60	0.02	0.64	0.19
Mother's SES	13.20	72.37	85.57	0.03	0.63	0.19
Family Occupation SES	16.47	63.25	79.72	0.03	0.68	0.21
Combined Family SES	28.89	61.10	89.99	0.05	0.67	0.22
City						
Father's SES	11.00	49.56	60.56	0.10	0.82	0.27
Mother's SES	12.69	67.44	80.13	0.09	0.79	0.27
Family Occupation SES	13.22	63.45	76.67	0.08	0.86	0.27
Combined Family SES	23.10	62.14	85.24	0.10	0.84	0.28

Table 3 (continued).

Metropolitan						
Father's SES	13.70	62.45	76.15	0.06	0.71	0.29
Family Occupation SES	16.23	44.97	61.20	0.05	0.53	0.22

Note. All estimates are statistically significant at $\alpha = 0.05$.

Table 4

Double Jeopardy Effects of Socioeconomic Status of Students and Schools on Mathematics Achievement in Germany

	Absolute		Adjusted	
	Effect	SE	Effect	SE
Rural Region				
Father's SES	7.14*	2.90	6.29*	2.94
Mean Father's SES	81.20*	14.68	55.35*	15.63
Mother's SES	1.77	3.17	0.82	3.01
Mean Mother's SES	101.31*	20.03	43.51*	17.59
Family Occupation SES	6.81*	2.81	5.46	2.80
Mean Family Occupation SES	116.69*	18.32	86.32*	18.43
Combined Family SES	12.95*	3.85	11.87*	4.33
Mean Combined Family SES	129.27*	16.49	106.59*	21.90
Town				
Father's SES	13.65*	2.80	10.75*	2.86
Mean Father's SES	109.10*	12.28	100.38*	11.19
Mother's SES	7.35*	3.17	7.76*	3.12
Mean Mother's SES	134.34*	16.97	118.32*	14.03
Family Occupation SES	12.89*	3.13	9.05*	3.21
Mean Family Occupation SES	111.76*	13.59	95.80*	11.13

Table 4 (continued).

Combined Family SES	18.60*	3.92	15.74*	3.99
Mean Combined Family SES	110.28*	13.43	92.46*	10.40
City				
Father's SES	9.18*	3.97	10.62*	3.63
Mean Father's SES	90.74*	26.09	103.64*	20.92
Mother's SES	3.29	4.62	4.83	4.65
Mean Mother's SES	110.99*	28.19	89.18*	15.75
Family Occupation SES	8.22	4.13	12.85*	3.70
Mean Family Occupation SES	92.60*	22.61	78.34*	17.60
Combined Family SES	14.51*	4.82	13.71*	4.83
Mean Combined Family SES	85.16*	22.08	78.37*	14.71
Metropolitan				
Father's SES	13.56*	4.91	13.23*	4.62
Mean Father's SES	96.07*	31.02	31.77*	13.85
Mother's SES	11.13	5.97	11.41*	5.30
Mean Mother's SES	121.15*	17.48	81.07*	17.15
Family Occupation SES	13.34*	4.28	12.90*	3.84

Table 4 (continued).

Mean Family Occupation SES	108.46*	22.64	71.25*	17.38
Combined Family SES	20.50*	4.32	15.16*	4.23
Mean Combined Family SES	86.74*	13.41	67.67*	12.66

* $p < 0.05$.

Table 5

Absolute Effect: Double Jeopardy of Socioeconomic Status to Mathematics Achievement for Socially Disadvantaged Students Attending Socially Disadvantaged Schools in Germany

	Double Jeopardy			Variance Explained		
	Family	School	Total	Student Level	School Level	Total
Rural Region						
Father's Socioeconomic Status (SES)	7.14	81.20	88.34	0.02	0.37	0.15
Family Occupation SES	6.81	116.69	123.50	0.01	0.58	0.23
Combined Family SES	12.95	129.27	142.22	0.02	0.68	0.27
Town						
Father's SES	13.65	109.10	122.75	0.10	0.70	0.59
Mother's SES	7.35	134.34	141.69	0.02	0.73	0.42
Family Occupation SES	12.89	111.76	124.65	0.04	0.79	0.46
Combined Family SES	18.60	110.28	128.88	0.05	0.83	0.49
City						
Father's SES	9.18	90.74	99.92	0.05	0.57	0.36
Combined Family SES	14.51	85.16	99.67	0.02	0.66	0.40

Table 5 (continued).

Metropolitan						
Father's SES	13.56	96.07	109.63	0.01	0.62	0.38
Family Occupation SES	13.34	108.46	121.80	0.04	0.87	0.54
Combined Family SES	20.50	86.74	107.24	0.05	0.91	0.57

Note. All estimates are statistically significant at $\alpha = 0.05$.

Table 6

Adjusted Effect: Double Jeopardy of Socioeconomic Status to Mathematics Achievement for Socially Disadvantaged Students Attending Socially Disadvantaged Schools in Germany

	Double Jeopardy			Variance Explained		
	Family	School	Total	Student Level	School Level	Total
Rural Region						
Father's Socioeconomic Status (SES)	6.29	55.35	61.64	0.06	0.64	0.29
Combined Family SES	11.87	106.59	118.46	0.06	0.69	0.30
Town						
Father's SES	10.75	100.38	111.13	0.15	0.76	0.50
Mother's SES	7.76	118.32	126.08	0.11	0.82	0.51
Family Occupation SES	9.05	95.80	104.85	0.12	0.86	0.54
Combined Family SES	15.74	92.46	108.20	0.12	0.89	0.56
City						
Father's SES	10.62	103.64	114.26	0.16	0.81	0.55
Family Occupation SES	12.85	78.34	91.19	0.16	0.88	0.59
Combined Family SES	13.71	78.37	92.08	0.16	0.90	0.60

Table 6 (continued).

Metropolitan						
Father's SES	13.23	31.77	45.00	0.09	0.95	0.61
Mother's SES	11.41	81.07	92.48	0.08	0.96	0.61
Family Occupation SES	12.90	71.25	84.15	0.10	0.97	0.62
Combined Family SES	15.16	67.67	82.83	0.12	0.97	0.63

Note. All estimates are statistically significant at $\alpha = 0.05$.

Table 7

Double Jeopardy Effects of Socioeconomic Status of Students and Schools on Mathematics Achievement in Italy

	Absolute		Adjusted	
	Effect	SE	Effect	SE
Rural Region				
Father's SES	2.98	3.90	2.45	4.03
Mean Father's SES	143.40*	34.13	157.92*	43.67
Mother's SES	9.84*	3.31	7.69*	3.36
Mean Mother's SES	15.63	48.42	-30.95	31.28
Family Occupation SES	8.18*	2.79	6.42*	3.24
Mean Family Occupation SES	132.25*	32.68	119.48*	32.49
Combined Family SES	10.68*	3.00	8.55*	3.13
Mean Combined Family SES	105.91*	29.83	95.24*	29.57
Town				
Father's SES	3.62	1.82	3.12	2.07
Mean Father's SES	109.18*	18.40	106.05*	20.19
Mother's SES	8.37*	2.27	7.00*	2.42
Mean Mother's SES	60.84*	12.79	60.77*	12.85
Family Occupation SES	6.33*	2.10	5.38*	2.21
Mean Family Occupation SES	100.25*	15.91	89.53*	13.75

Table 7 (continued).

Combined Family SES	9.14*	1.85	7.63*	1.93
Mean Combined Family SES	105.32*	19.17	106.69*	21.92
City				
Father's SES	2.94	2.77	1.28	2.66
Mean Father's SES	133.01*	48.07	129.49*	31.44
Mother's SES	11.00*	3.29	9.78*	2.97
Mean Mother's SES	51.18*	13.83	98.98*	30.45
Family Occupation SES	6.92*	3.06	5.04	2.79
Mean Family Occupation SES	112.89*	40.73	109.83*	25.88
Combined Family SES	10.38*	3.26	8.32*	2.95
Mean Combined Family SES	104.80*	25.17	101.06*	15.76
Metropolitan				
Father's SES	0.42	8.97	3.99	7.41
Mean Father's SES	190.93*	25.09	135.88*	24.65
Mother's SES	18.37*	5.57	18.00*	6.23
Mean Mother's SES	115.07*	27.46	72.60*	21.90
Family Occupation SES	10.47	8.99	10.45	7.86

Table 7 (continued).

Mean Family Occupation SES	135.53*	22.62	98.40*	20.83
Combined Family SES	12.93	7.50	14.80*	6.53
Mean Combined Family SES	137.59*	23.44	102.61*	19.49

* $p < 0.05$.

Table 8

Absolute Effect: Double Jeopardy of Socioeconomic Status to Mathematics Achievement for Socially Disadvantaged Students Attending Socially Disadvantaged Schools in Italy

	Double Jeopardy			Variance Explained		
	Family	School	Total	Student Level	School Level	Total
Rural Region						
Family Occupation SES	8.18	132.25	140.43	0.00	0.46	0.32
Combined Family SES	10.68	105.91	116.59	0.01	0.49	0.34
Town						
Mother's SES	8.37	60.84	69.21	0.02	0.54	0.32
Family Occupation SES	6.33	100.25	106.58	0.01	0.50	0.29
Combined Family SES	9.14	105.32	114.46	0.01	0.69	0.41
City						
Mother's SES	11.00	51.18	62.18	0.03	0.23	0.16
Family Occupation SES	6.92	112.89	119.81	0.00	0.47	0.30
Combined Family SES	10.38	104.80	115.18	0.02	0.68	0.44
Metropolitan						
Mother's SES	18.37	115.07	133.44	0.07	0.92	0.78

Note. All estimates are statistically significant at $\alpha = 0.05$.

Table 9

Adjusted Effect: Double Jeopardy of Socioeconomic Status to Mathematics Achievement for Socially Disadvantaged Students Attending Socially Disadvantaged Schools in Italy

	Double Jeopardy			Variance Explained		
	Family	School	Total	Student Level	School Level	Total
Rural Region						
Family Occupation SES	6.42	119.48	125.90	0.02	0.59	0.42
Combined Family SES	8.55	95.24	103.79	0.03	0.60	0.42
Town						
Mother's SES	7.00	60.77	67.77	0.06	0.61	0.38
Family Occupation SES	5.38	89.53	94.91	0.05	0.51	0.32
Combined Family SES	7.63	106.69	114.32	0.05	0.69	0.42
City						
Mother's SES	9.78	98.98	108.76	0.07	0.54	0.37
Combined Family SES	8.32	101.06	109.38	0.04	0.76	0.51
Metropolitan						
Mother's SES	18.00	72.60	90.60	0.05	0.97	0.82
Combined Family SES	14.80	102.61	117.41	0.03	0.98	0.82

Note. All estimates are statistically significant at $\alpha = 0.05$.

Table 10

Double Jeopardy Effects of Socioeconomic Status of Students and Schools on Mathematics Achievement in Japan

	Absolute		Adjusted	
	Effect	SE	Effect	SE
Rural Region				
Father's SES	1.28	8.43	1.00	8.00
Mean Father's SES	175.57*	32.28	115.60*	13.79
Mother's SES	13.25	9.96	10.19	11.19
Mean Mother's SES	278.35*	55.84	180.31*	50.57
Family Occupation SES	11.03	9.23	9.09	10.57
Mean Family Occupation SES	205.99*	31.12	155.96*	24.47
Combined Family SES	16.28	10.06	11.97	12.33
Mean Combined Family SES	190.22*	35.60	138.46*	31.21
Town				
Father's SES	-1.66	4.29	-5.00	4.45
Mean Father's SES	190.71*	32.83	211.56*	31.32
Mother's SES	-5.64	3.65	-6.05	4.05
Mean Mother's SES	160.79*	37.15	132.84*	27.17
Family Occupation SES	-4.12	3.49	-5.07	3.85
Mean Family Occupation SES	190.65*	32.58	184.77*	25.30

Table 10 (continued).

Combined Family SES	0.88	5.62	0.10	5.48
Mean Combined Family SES	194.93*	28.93	221.01*	24.12
City				
Father's SES	0.75	3.26	-0.37	3.47
Mean Father's SES	158.93*	22.43	187.73*	26.55
Mother's SES	-2.96	3.72	-4.35	3.82
Mean Mother's SES	176.00*	32.21	173.35*	38.33
Family Occupation SES	-0.54	4.06	-1.81	4.15
Mean Family Occupation SES	172.87*	23.70	173.70*	27.41
Combined Family SES	-0.87	4.95	-0.89	4.85
Mean Combined Family SES	170.11*	13.53	178.43*	12.96
Metropolitan				
Father's SES	3.02	4.25	4.24	4.01
Mean Father's SES	144.43*	41.66	187.94*	36.21
Mother's SES	9.32*	3.72	9.62*	3.58
Mean Mother's SES	179.27*	57.90	233.62*	48.24
Family Occupation SES	8.15*	2.92	9.91*	3.08

Table 10 (continued).

Mean Family Occupation SES	220.23*	46.33	245.04*	39.41
Combined Family SES	17.83*	6.75	19.92*	6.75
Mean Combined Family SES	154.53*	31.11	158.40*	18.93

* $p < 0.05$.

Table 11

Absolute Effect: Double Jeopardy of Socioeconomic Status to Mathematics Achievement for Socially Disadvantaged Students Attending Socially Disadvantaged Schools in Japan

	Double Jeopardy			Variance Explained		
	Family	School	Total	Student Level	School Level	Total
Metropolitan						
Mother's SES	9.32	179.27	188.59	0.07	0.39	0.25
Family Occupation SES	8.15	220.23	228.38	0.07	0.60	0.37
Combined Family SES	17.83	154.53	172.36	0.04	0.70	0.42

Note. All estimates are statistically significant at α = 0.05.

Table 12

Adjusted Effect: Double Jeopardy of Socioeconomic Status to Mathematics Achievement for Socially Disadvantaged Students Attending Socially Disadvantaged Schools in Japan

	Double Jeopardy			Variance Explained		
	Family	School	Total	Student Level	School Level	Total
Metropolitan						
Mother's SES	9.62	233.62	243.24	0.11	0.65	0.42
Family Occupation SES	9.91	245.04	254.95	0.10	0.79	0.49
Combined Family SES	19.92	158.40	178.32	0.10	0.87	0.54

Note. All estimates are statistically significant at $\alpha = 0.05$.

Table 13

Double Jeopardy Effects of Socioeconomic Status of Students and Schools on Mathematics Achievement in the Russian Federation

	Absolute		Adjusted	
	Effect	SE	Effect	SE
Rural Region				
Father's SES	12.67*	2.86	12.31*	3.00
Mean Father's SES	-0.20	17.18	13.71	17.73
Mother's SES	12.67*	2.86	11.07*	2.93
Mean Mother's SES	-21.74	24.45	-7.79	22.97
Family Occupation SES	14.72*	2.78	12.72*	2.75
Mean Family Occupation SES	-19.66	20.80	-8.39	19.96
Combined Family SES	29.99*	4.47	26.59*	4.53
Mean Combined Family SES	-20.16	27.00	-3.61	23.03
Town				
Father's SES	7.39	4.94	8.34	4.14
Mean Father's SES	73.80*	22.83	74.10*	21.33
Mother's SES	6.72	4.21	7.71	4.29
Mean Mother's SES	108.13*	24.58	102.44*	28.33
Family Occupation SES	9.18*	4.27	10.10*	4.19
Mean Family Occupation SES	88.00*	22.89	89.15*	18.68

Table 13 (continued).

Combined Family SES	19.21*	5.50	19.31*	5.58
Mean Combined Family SES	85.52*	31.16	97.03*	20.35
City				
Father’s SES	8.98*	2.71	9.35*	2.73
Mean Father’s SES	72.90*	29.26	51.34*	18.42
Mother’s SES	11.15*	3.05	12.31*	3.11
Mean Mother’s SES	95.46*	17.73	76.11*	12.69
Family Occupation SES	11.44*	3.19	12.05*	3.23
Mean Family Occupation SES	107.43*	18.86	86.63*	14.11
Combined Family SES	20.60*	3.87	21.56*	3.90
Mean Combined Family SES	116.47*	27.78	91.43*	19.69
Metropolitan				
Father’s SES	12.85*	3.75	14.04*	3.85
Mean Father’s SES	77.86*	24.31	67.59*	21.67
Mother’s SES	11.26*	3.10	10.59*	3.21
Mean Mother’s SES	71.58*	24.67	65.81*	24.87
Family Occupation SES	12.90*	3.73	13.75*	3.72

Table 13 (continued).

Mean Family Occupation SES	73.28*	23.92	66.18*	23.43
Combined Family SES	25.15*	5.37	25.16*	5.52
Mean Combined Family SES	98.22*	23.92	105.02*	24.64

* $p < 0.05$.

Table 14

Absolute Effect: Double Jeopardy of Socioeconomic Status to Mathematics Achievement for Socially Disadvantaged Students Attending Socially Disadvantaged Schools in the Russian Federation

	Double Jeopardy			Variance Explained		
	Family	School	Total	Student Level	School Level	Total
Town						
Family Occupation SES	9.18	88.00	97.18	0.02	0.40	0.14
Combined Family SES	19.21	85.52	104.73	0.03	0.37	0.14
City						
Father's SES	8.98	72.90	81.88	0.05	0.37	0.13
Mother's SES	11.15	95.46	106.61	0.03	0.66	0.18
Family Occupation SES	11.44	107.43	118.87	0.03	0.65	0.18
Combined Family SES	20.60	116.47	137.07	0.03	0.54	0.15
Metropolitan						
Father's SES	12.85	77.86	90.71	0.01	0.42	0.15
Mother's SES	11.26	71.58	82.84	0.05	0.29	0.14
Family Occupation SES	12.90	73.28	86.18	0.03	0.37	0.15
Combined Family SES	25.15	98.22	123.37	0.04	0.54	0.22

Note. All estimates are statistically significant at $\alpha = 0.05$.

Table 15

Adjusted Effect: Double Jeopardy of Socioeconomic Status to Mathematics Achievement for Socially Disadvantaged Students Attending Socially Disadvantaged Schools in the Russian Federation

	Double Jeopardy			Variance Explained		
	Family	School	Total	Student Level	School Level	Total
Town						
Family Occupation SES	10.10	89.15	99.25	0.05	0.57	0.22
Combined Family SES	19.31	97.03	116.34	0.06	0.60	0.24
City						
Father's SES	9.35	51.34	60.69	0.06	0.61	0.19
Mother's SES	12.31	76.11	88.43	0.03	0.79	0.22
Family Occupation SES	12.05	86.63	98.68	0.04	0.77	0.22
Combined Family SES	21.56	91.43	112.99	0.04	0.69	0.19
Metropolitan						
Father's SES	14.04	67.59	81.63	0.05	0.49	0.20
Mother's SES	10.59	65.81	76.40	0.10	0.34	0.18
Family Occupation SES	13.75	66.18	79.93	0.08	0.43	0.20
Combined Family SES	25.16	105.02	130.18	0.10	0.58	0.27

Note. All estimates are statistically significant at $\alpha = 0.05$.

Table 16

Double Jeopardy Effects of Socioeconomic Status of Students and Schools on Mathematics Achievement in the United Kingdom

	Absolute		Adjusted	
	Effect	SE	Effect	SE
Rural Region				
Father's SES	20.83*	2.56	20.69*	2.68
Mean Father's SES	27.54*	10.67	30.59*	8.58
Mother's SES	14.80*	3.61	15.99*	3.89
Mean Mother's SES	37.36*	12.29	35.72*	10.08
Family Occupation SES	23.76*	2.65	23.89*	3.42
Mean Family Occupation SES	32.63*	9.95	33.79*	8.56
Combined Family SES	35.53*	4.08	35.94*	4.16
Mean Combined Family SES	23.36*	10.70	23.68*	9.22
Town				
Father's SES	17.20*	2.31	15.73*	2.35
Mean Father's SES	72.40*	10.75	63.35*	10.02
Mother's SES	12.24*	3.27	11.85*	3.24
Mean Mother's SES	100.97*	11.70	89.54*	12.40
Family Occupation SES	18.65*	2.54	16.98*	2.75
Mean Family Occupation SES	90.00*	9.54	82.25*	9.55

Table 16 (continued).

Combined Family SES	30.57*	2.78	28.48*	2.96
Mean Combined Family SES	77.35*	8.75	70.68*	8.54
City				
Father's SES	19.48*	3.61	19.58*	3.46
Mean Father's SES	65.59*	9.79	58.77*	7.90
Mother's SES	13.39*	3.03	13.22*	3.39
Mean Mother's SES	72.66*	14.16	75.52*	8.74
Family Occupation SES	21.80*	3.21	20.87*	3.39
Mean Family Occupation SES	66.41*	12.10	66.21*	7.97
Combined Family SES	32.15*	3.86	32.01*	4.16
Mean Combined Family SES	63.34*	9.78	60.87*	6.95
Metropolitan				
Father's SES	4.68	4.78	4.53	4.90
Mean Father's SES	68.84*	15.19	61.68*	11.46
Mother's SES	6.83	7.85	5.86	7.67
Mean Mother's SES	59.20	43.08	39.79	31.97
Family Occupation SES	11.55	6.53	10.30	6.79

Table 16 (continued).

Mean Family Occupation SES	62.69	35.15	43.14	26.82
Combined Family SES	27.65*	6.47	21.86*	7.26
Mean Combined Family SES	74.69*	24.05	63.14*	14.22

* $p < 0.05$.

Table 17

Absolute Effect: Double Jeopardy of Socioeconomic Status to Mathematics Achievement for Socially Disadvantaged Students Attending Socially Disadvantaged Schools in the United Kingdom

	Double Jeopardy			Variance Explained		
	Family	School	Total	Student Level	School Level	Total
Rural Region						
Father's Socioeconomic Status (SES)	20.83	27.54	48.37	0.11	0.46	0.15
Mother's SES	14.80	37.36	52.16	0.08	0.48	0.13
Family Occupation SES	23.76	32.63	56.39	0.09	0.50	0.14
Combined Family SES	35.53	23.36	58.89	0.11	0.53	0.16
Town						
Father's SES	17.20	72.40	89.60	0.07	0.72	0.34
Mother's SES	12.24	100.97	113.21	0.04	0.80	0.35
Family Occupation SES	18.65	90.00	108.65	0.06	0.83	0.38
Combined Family SES	30.57	77.35	107.92	0.09	0.85	0.41

Table 17 (continued).

City						
Father’s SES	19.48	65.59	85.07	0.07	0.96	0.37
Mother’s SES	13.39	72.66	86.05	0.04	0.84	0.31
Family Occupation SES	21.80	66.41	88.21	0.07	0.94	0.36
Combined Family SES	32.15	63.34	95.49	0.10	0.96	0.39
Metropolitan						
Combined Family SES	27.65	74.69	102.34	0.09	0.82	0.32

Note. All estimates are statistically significant at $\alpha = 0.05$.

Table 18

Adjusted Effect: Double Jeopardy of Socioeconomic Status to Mathematics Achievement for Socially Disadvantaged Students Attending Socially Disadvantaged Schools in the United Kingdom

	Double Jeopardy			Variance Explained		
	Family	School	Total	Student Level	School Level	Total
Rural Region						
Father's Socioeconomic Status (SES)	20.69	30.59	51.28	0.11	0.58	0.17
Mother's SES	15.99	35.72	51.71	0.09	0.60	0.15
Family Occupation SES	23.89	33.79	57.68	0.10	0.60	0.16
Combined Family SES	35.94	23.68	59.62	0.12	0.62	0.18
Town						
Father's SES	15.73	63.35	79.08	0.08	0.80	0.37
Mother's SES	11.85	89.54	101.39	0.07	0.83	0.38
Family Occupation SES	16.98	82.25	99.23	0.08	0.87	0.40
Combined Family SES	28.48	70.68	99.16	0.11	0.90	0.43
City						
Father's SES	19.58	58.77	78.35	0.08	0.96	0.37
Mother's SES	13.22	75.52	88.74	0.06	0.91	0.34
Family Occupation SES	20.87	66.21	87.08	0.08	0.96	0.37

Table 18 (continued).

Combined Family SES	32.01	60.87	92.88	0.11	0.98	0.40
Metropolitan						
Combined Family SES	21.86	63.14	85.00	0.10	0.90	0.36

Note. All estimates are statistically significant at $\alpha = 0.05$.

Table 19

Double Jeopardy Effects of Socioeconomic Status of Students and Schools on Mathematics Achievement in the United States

	Absolute		Adjusted	
	Effect	SE	Effect	SE
Rural Region				
Father's SES	10.75*	3.61	9.02*	3.39
Mean Father's SES	33.69	35.84	38.69	35.80
Mother's SES	18.65*	4.27	15.78*	3.55
Mean Mother's SES	55.13*	22.63	63.27	36.64
Family Occupation SES	16.94*	3.90	14.12*	3.80
Mean Family Occupation SES	48.27*	18.08	63.68	32.04
Combined Family SES	29.42*	4.98	26.34*	5.20
Mean Combined Family SES	41.89*	13.59	61.15*	22.83
Town				
Father's SES	13.87*	4.53	12.84*	4.35
Mean Father's SES	111.40*	20.24	84.23*	12.86
Mother's SES	12.14*	4.12	12.42*	4.95
Mean Mother's SES	152.58*	28.45	147.94*	22.06
Family Occupation SES	15.99*	4.29	15.02*	4.67
Mean Family Occupation SES	135.95*	19.43	100.86*	12.93

Table 19 (continued).

Combined Family SES	21.74*	8.92	24.79*	6.71
Mean Combined Family SES	113.25*	21.73	101.44*	19.64
City				
Father's SES	12.61*	4.40	12.56*	4.31
Mean Father's SES	29.95	21.22	22.93*	10.64
Mother's SES	1.47	8.73	6.03	7.64
Mean Mother's SES	131.38*	34.73	80.93*	17.51
Family Occupation SES	10.02	6.73	7.12	6.76
Mean Family Occupation SES	52.41	33.05	73.45*	9.61
Combined Family SES	19.44*	7.61	15.83	9.56
Mean Combined Family SES	103.06*	18.44	81.99*	16.88
Metropolitan				
Father's SES	34.96*	5.02	31.81*	4.97
Mean Father's SES	77.96*	17.32	75.27*	15.57
Mother's SES	19.36*	9.03	24.03*	9.82
Mean Mother's SES	114.47	52.13	58.97*	23.17
Family Occupation SES	27.75*	6.77	27.52*	6.59

Table 19 (continued).

Mean Family Occupation SES	127.76*	23.78	75.48*	20.28
Combined Family SES	46.18*	9.79	43.99*	11.04
Mean Combined Family SES	123.51*	23.08	74.64*	27.90

* $p < 0.05$.

Table 20

Absolute Effect: Double Jeopardy of Socioeconomic Status to Mathematics Achievement for Socially Disadvantaged Students Attending Socially Disadvantaged Schools in the United States

	Double Jeopardy			Variance Explained		
	Family	School	Total	Student Level	School Level	Total
Rural Region						
Mother's SES	18.65	55.13	73.78	0.10	0.30	0.12
Family Occupation SES	16.94	48.27	65.21	0.07	0.36	0.10
Combined Family SES	29.42	41.89	71.31	0.09	0.61	0.15
Town						
Father's SES	13.87	111.40	125.27	0.06	0.64	0.32
Mother's SES	12.14	152.58	164.72	0.01	0.76	0.35
Family Occupation SES	15.99	135.95	151.94	0.04	0.66	0.32
Combined Family SES	21.74	113.25	134.99	0.04	0.89	0.42
City						
Combined Family SES	19.44	103.06	122.50	0.01	0.77	0.33

Table 20 (continued).

Metropolitan						
Father’s SES	34.96	77.96	112.92	0.13	0.82	0.37
Family Occupation SES	27.75	127.76	155.51	0.07	0.98	0.38
Combined Family SES	46.18	123.51	169.69	0.15	0.91	0.42

Note. All estimates are statistically significant at $\alpha = 0.05$.

Table 21

Adjusted Effect: Double Jeopardy of Socioeconomic Status to Mathematics Achievement for Socially Disadvantaged Students Attending Socially Disadvantaged Schools in the United States

	Double Jeopardy			Variance Explained		
	Family	School	Total	Student Level	School Level	Total
Rural Region						
Combined Family SES	26.34	61.15	87.49	0.12	0.81	0.20
Town						
Father's SES	12.84	84.23	97.07	0.07	0.87	0.43
Mother's SES	12.42	147.94	160.36	0.03	0.90	0.42
Family Occupation SES	15.02	100.86	115.88	0.05	0.85	0.41
Combined Family SES	24.79	101.44	126.23	0.06	0.92	0.45
City						
Father's SES	12.56	22.93	35.49	0.05	0.90	0.41

Table 21 (continued).

Metropolitan						
Father's SES	31.81	75.27	107.08	0.11	0.97	0.41
Mother's SES	24.03	58.97	83.00	0.12	0.99	0.43
Family Occupation SES	27.52	75.48	103.00	0.08	0.99	0.40
Combined Family SES	43.99	74.64	118.63	0.16	0.99	0.48

Note. All estimates are statistically significant at $\alpha = 0.05$.

Chapter 5

Discussion and Conclusions

Chapter 5 consists of five sections: (a) Principal findings, (b) Comparative Syntheses, (c) Contributions to the Literature, (d) Policy implications, and (e) Limitations and Future Studies. The principal findings for the G8 countries (excluding France) are divided into school location, according to the SES variables that are significant for the double jeopardy phenomenon, and by SES measure. Because of the complexity of the factors considered in this discussion, each country will be addressed separately, including (a) an overview of the double jeopardy results, (b) discussion of socioeconomic conditions that can help make sense of the double jeopardy results, (c) a brief summary of the factors, and (d) policy implications specific to each country. Specifically, the policy implications attempt to delineate how double jeopardy affects mathematics achievement, as well as the ways in which the impact of this phenomenon, in regards to specific countries, can be lessened.

Principal Findings

This study attempted to analyze the phenomenon of double jeopardy in mathematics achievement for socially disadvantaged students, across four school locations (rural regions, towns, cities, and metropolitan areas), in seven of the G8 countries (Canada, Germany, Italy, Japan, the Russian Federation, the United Kingdom, and the United States). Moreover, this study examined the double jeopardy phenomenon associated with four different SES measures (father's SES, mother's SES, family occupation SES, and combined family SES).

Because double jeopardy is a situation of dual penalties, one penalty occurring at the student level and one at the school level, the impact of double jeopardy was estimated by examining the effects of both student-level SES and school-level SES on mathematics achievement. In general, this study found that double jeopardy did occur in mathematics achievement; however, it was not a foregone conclusion, instead, the results varied by school location, SES measure, and country.

As indicated above, discussions on the patterns or occurrences of the double jeopardy phenomenon were divided into two sections: school location and SES measure. Because the adjusted double jeopardy models utilized control variables, the double jeopardy effects that remained after the adjustment over school-level and student-level control variables were truly powerful indicators of double jeopardy in mathematics achievement. As such, these adjusted double jeopardy models were used for the discussion of the double jeopardy effect by school location, SES measure, and country.

According to the classification system of Rosenthal and Rosnow (1984), the vast majority of the double jeopardy effects in this study were large in magnitude (greater than 50 percent of a standard deviation), across school locations and from country to country. In fact, only the effects associated with the father's SES in the rural region in Canada, the metropolitan areas in Germany, and the city location in the United States were not considered large. Conversely, the remainder of the double jeopardy effects were all large for Canada, Germany, and the United States. All of the double jeopardy effects for Italy, Japan, the Russian Federation, and the United Kingdom were large. As such, it is evident that the dual penalties associated with mathematics achievement are very real for socially disadvantaged students throughout the G8 countries.

In addition, the school-level effects always appear to be much greater than the student level effects in all occurrences of double jeopardy by school location, by SES measure, and by country. Similarly, a greater majority of the variance is accounted for at the school level than the student level in all the double jeopardy models exhibiting the double jeopardy phenomenon. With the exception of some of the double jeopardy models for Canada and Italy, all of the models for the G8 countries account for an acceptable amount of the total variance. Even in the case of Canada and Italy models, the main concern lies with the proportion of variance accounted for at the student level in several models, not necessarily in the overall proportion of variance explained. Thus, it is evident that the vast majority of the adjusted double jeopardy models fit the data adequately.

Canada

Background. In order to make sense of the double jeopardy results on mathematics achievement in Canada, influential socioeconomic factors at both the student level and school level are identified and discussed. Although two of the most notable factors for Canada are population composition and distribution, factors such as employment, unemployment, incidence of low-income, and the educational system are also influential to the life of people in Canada.

With a population of approximately 32,299,496 people in 2005, Canada has a relatively small population encompassed within a vast land area, consisting of ten provinces and three territories (*Statistics Canada*, 2008). The diversity evident within the population – resulting from population composition, language spoken, and religious affiliation – has created governmentally-sanctioned cultures, which often influence national and provincial regulations, as well as the educational system (“Canada,” 2008). For example, each province has the right to include not only religious affiliations in the public school systems, but also to determine the extent of the influence of each religion, by establishing separate school systems or providing access to schools of differing religions (“Canada,” 2008). As such, some provinces show preference for one or two religions over the rest (i.e., Quebec favors Catholicism), resulting in vastly different educational and cultural experiences throughout Canada.

Similar to population composition, population distribution in Canada is an important factor for understanding double jeopardy; specifically, this distribution speaks to the division between rural and urban areas. According to Fisher (2002), more than 80 percent of Canadians live in urban centers, within 100 miles of the border with the United States. This area, which has the highest population density in Canada, falls into the Quebec City-Windsor Corridor, along the Great Lakes and Saint Lawrence River in the southeast. This means that, in 2001, approximately 23,908,000 people resided within a small corridor of the country, while approximately 6,099,000 people resided in rural areas throughout the remainder of the country (*Statistics Canada*, 2008). Moreover, based on a 2003 census, 75 percent of the total population live in cities or metropolitan areas, including Toronto (5.1 million), Montreal (3.6 million), and Vancouver (2.1 million) (*Statistics Canada*, 2008; *U.S. Department of State Background Note: Canada*, 2008).

With a labor force of 16,954,000 million people (15 and older) in 2003, and an unemployment rate of 7.2 percent, approximately 15.7 million people were employed: 12.7 million full-time and 2.9 million part-time (*Comparative Civilian Labor Force Statistics, 10 Countries, 1960-2004*, 2005; *Statistics Canada*, 2008). Although the national unemployment rate was approximately 7 percent, the unemployment rates throughout Canada differed by province (i.e., Alberta- 3.6 percent and Newfoundland and Labrador- 14.6 percent), emphasizing economic inequalities in income and employment opportunities throughout the country (*Statistics Canada*, 2008)

While the differences in employment and unemployment rates throughout Canada do affect the socioeconomic status of individuals and families, the incidence of low-income is a better indicator of low SES. In 2003, 15.9 percent of the Canadian population lived below the poverty line, as calculated by the Low Income Cut-Off (LICO), or 11.6 percent of the population after tax (*Statistics Canada*, 2008; *The World Factbook: Canada*, 2008). Similar to employment opportunities, the incidence of low income also varied by province. For example, in 2000, the incidence of low income in Canada was 16.2 percent, while the incidence of low income in the provinces of Newfoundland and Labrador and in Prince Edward Island was 18.8 percent and 12.6 percent, respectively (*Statistics Canada*, 2008).

According to Rodney Clifton, of all the G8 countries, Canada is the "only country without a national office of education: all other nations… have national offices of education that coordinate and/or administer various aspects of their educational system" (as cited in Fisher, 2002). In other words, each province in Canada is responsible for and has created its own education system, which often differs according to regional history, culture, religion, and geography (Fisher, 2002). These separate school systems, while similar in many ways, often differ concerning the ages for compulsory education, the educational structure, and the curriculum.

In general, the different Canadian education systems maintain three common social and educational values: equality of access, equality of opportunity, and cultural pluralism (*Canadian Education System*, 2008; Fisher, 2002). Furthermore, the educational standards tend to be universally high throughout the country (*Study Canada*, 2003; *Canadian Education System*, 2008). However, because each province sets the curriculum and other standards for the schools (including private, independent, and publicly-funded schools) and regulates all post-secondary education in the province, education throughout Canada widely differs, due, in part, to the school structure, the language and culture emphasized, and the type and extent of religious affiliation (*Study Canada*, 2003; *Canadian Education System*, 2008).

Because Canada has two official languages (English and French), education is available in both languages, but to a greater or lesser degree, depending on the region (Fisher, 2002). For example, French is extensively used in Quebec, where the French tradition and language have dominated the educational system, while the majority of the other provinces primarily use English for official and educational purposes, and focus on a history and tradition rooted in Great Britain (Fisher, 2002). Similarly, the extent of the inclusion of religious schools (primarily Catholic and Protestant) within the public education system also differs by province (*Teaching in Canada*, 2008). Although the majority of provinces emphasize Catholic and Protestant leanings in schools, in British Columbia denominational minorities are allowed to operate separate school systems, and in Newfoundland there is a secular system of education (*Teaching in Canada*, 2008; Fisher, 2002).

In Canada, education is generally required from age six or seven to age sixteen, although the ages for compulsory schooling actually vary from one province to another, ranging from 5–7 to 16–18 years (Fisher, 2002; *Canadian Education System*, 2008). Similar to the age range for compulsory schooling, the educational structure throughout Canada is fairly consistent between the provinces. The most common structure for education in Canada is a progression from elementary school (ages 5 to 13) to secondary school (ages 13 or 14 to 18) to post-secondary school. This system is often broken down even further into kindergarten to grade 3 (ages 5-8), elementary school (4th –7th grades, ages 9-12), and secondary school (8th –12th grades, ages 13-17) ("Schooling," 2005; *Canadian Education System*, 2008).

Although different from province to province, the same generalizations for the school curriculum exist. Specifically, all educational systems require core classes for each respective grade level or educational division. For example, the required courses for grades 8 and 9 are English language arts, mathematics, social studies, science, physical education, and career and personal planning ("Schooling," 2005). Only in secondary school are students given optional subjects to pursue, such as the fine arts and applied skills ("Schooling," 2005). Students can also choose to study a variety of academic programs, including an integrated academic and English program, workplace preparation, and university/college preparation (*Study Canada*, 2003; *Canadian Education System*, 2008). Thus, the fairly rigid curriculum of the elementary years, which focuses on basic skills and knowledge, gives way to a more open curriculum, focused on the future and the choice of occupation: hands-on careers (i.e., electrician or policeman), vocationallyoriented careers (i.e., mechanic), and professional careers (i.e., doctor or teacher) (*Canadian Education System*, 2008).

Principal Findings from Canada. As indicated in Chapter 4, all four school locations (rural areas, towns, cities, and metropolitan areas) in Canada exhibited adjusted double jeopardy effects. Moreover, adjusted double jeopardy effects were also evident for all four SES measures (father's SES, mother's SES, family occupation SES, and combined family SES); although the results differed according to the school location. The widespread nature of double jeopardy throughout Canada, in combination with the magnitude of the adjusted double jeopardy effects, indicates that the double jeopardy phenomenon was a very substantial and powerful factor in mathematics achievement. Thus, it is evident that socially disadvantaged students in Canada were seriously penalized, by both coming from low-SES families and going to low-SES schools.

The double jeopardy results, however, were not uniform or consistent throughout the school locations or SES measures. Of the four SES measures, the SES measure most sensitive to double jeopardy in Canada was the father's SES. This determination was made based on two criteria: 1) how widespread double jeopardy was for each of the SES measures across the four school locations; and 2) the amount of the variance explained (i.e., whether the amount of variance explained in each double jeopardy model associated with the SES measure was reasonable). Similarly, the city location was the most sensitive, of the four school locations, to the double jeopardy phenomenon in Canada, as it had the most widespread double jeopardy effects across the four SES measures. The city location also accounted for a reasonable amount of variance explained in each case.

Other characteristics of double jeopardy, unique to Canada, are as follows: 1) double jeopardy was limited in rural areas to father's SES; 2) all four SES measures indicated double jeopardy effects in the town and city locations; 3) the mother's SES and the combined family SES displayed the least widespread occurrence of double jeopardy, as the double jeopardy effects were limited to the town and city locations; and 4) the town location exhibited the largest double jeopardy effects for the mother's SES, the family occupation SES, and the combined family SES.

Germany

Background. Similar to Canada, influential socioeconomic factors, at both the student level and school level, are identified and discussed for Germany in order to make sense of the double jeopardy results in mathematics achievement. Some of the most notable factors for Germany are population size, distribution, and density; however, factors such as unemployment, social structure, and the educational system are also influential in the life of people in Germany.

With a population of approximately 82.5 million people in 2003, Germany has a relatively large population (*The Education System in Germany*, 2008; Solsten, 2005). However, this population is not spread evenly throughout the country. In 2003, an overwhelming majority of the German population resided in rural areas and towns (9 percent and 61 percent respectively), while only 30 percent resided in cities and metropolitan areas (*The Education System in Germany*, 2008; Solsten, 2005). In addition to this uneven population distribution, Germany also has vast differences in population density, primarily reflecting the former division of East and West Germany. The western region of Germany, which has the majority of cities and metropolitan areas (with populations over 200,000), has a much higher population density than the eastern region (*The Education System in Germany*, 2008). However, urban areas in the east are more densely populated than those in the west, resulting in a greater contrast between the urban and rural areas across the regions (McClave, 1995).

This contrast, and the distribution of the population centers between the two regions, is a reflection of the difficulties and differences inherent in the on-going unification process of eastern and western Germany. As such, population, along with regional identity, is an important factor for understanding double jeopardy in Germany. For example, in the former West Germany, the people are upwardly mobile and success-oriented, with a focus on personal fulfillment, recreation, health, and the environment. In contrast, the former East German society places a greater emphasis on work and many have come to depend on state-provided guaranteed employment, free education and health care, and subsidized low rent (McClave, 1995). The forced re-socialization of the eastern-German population has resulted in a deep chasm between the two German segments, making those in eastern Germany second-class citizens (McClave, 1995).

This chasm between the eastern and western segments of Germany is also reflected in economic, social, and educational differences. Economic divisions within the two regions of Germany have created an atmosphere of widespread economic inequality, and chronically high unemployment rates affect the socioeconomic status of individuals and families. Although both regions of the country have adopted similar wages and benefits, the economy continues to show large disparities in terms of unemployment (Solsten, 2005). In 2003, approximately 10.5 percent of the German population was unemployed; however, a higher percentage of the unemployed resided in eastern Germany (18.4 percent) than in western Germany (8.5 percent) (*The Education System in Germany*, 2008; Solsten, 2005). In fact, in some eastern *Länder,* or states, the rate of unemployment has approached 20 percent (Solsten, 2005).

The German social structure, which is based on economic and social indicators (i.e., education and average income), also reflects a similar chasm within the German population. Specifically, the German social structure divides the society into the elite, the self-employed, salaried employees, civil servants, workers (i.e., elite workers, skilled workers, and unskilled workers), and the poor (McClave, 1995). Although this social structure is both well established and very stringent, it does allow for upward mobility (i.e., social advancement and the increase of socioeconomic status); however, this mobility is often based on education and other training (McClave, 1995). As such, the opportunity for social mobility can be limited by region or type of occupation. For example, the western region of Germany, which has primarily service-related occupations, has more upward mobility in the social structure, while the eastern region of Germany, which is primarily agricultural and industrial, has a larger percentage of farmers and workers and less social mobility (McClave, 1995). For the poor, which was as much as 11 percent of the population in 2001, social mobility is almost nil for the vast majority of single-parent families and households with three or more children, who often rely on welfare and other social assistance (i.e., unemployment insurance and housing subsidies) (McClave, 1995; Solsten, 2005).

The German education system is one of the best and most extensive in the world, as indicated by the academic achievement of students, the length of the mandatory education, and the manner in which the differing needs and abilities of students are addressed (Altenstetter, 1995). Because education is viewed as constitutional right and a public responsibility in Germany, the educational system emphasizes the importance of general education; however, it also offers a range of educational choices and opportunities, including teaching vocational education through a dual-system, a combination of classroom instruction and on-the-job training (Altenstetter, 1995; *The Education System in Germany*, 2008).

Although students are mandated to attend a total of twelve years of schooling, with compulsory schooling beginning at the age of six and lasting for a minimum of nine years, the differentiation among school programs begins at a relatively early age (Altenstetter, 1995; *The Education System in Germany*, 2008; Solsten, 2005). At the approximate age of 10, during the fourth grade, students are evaluated for their future educational needs and goals, in order to determine which curricular track or program they will pursue, and thus, the type of secondary school they will attend: the *Hauptschule*, the *Realschule*, the *Gymnasium*, or the *Gesamtschule* (Altenstetter, 1995; Solsten, 2005; *The Education System in Germany*, 2008).

After primary school is concluded, each student's curriculum in the intermediate secondary schools (5th and 6th grades) begins to increasingly incorporate more of a curricular track or a program specially designated for the student. Some students receive traditional classroom-based education, which prepares the students for higher education, and others receive vocational training with on-the-job training and classroom instruction, which prepares students to enter the workforce or specialized profession (Altenstetter, 1995). The remainder of the students' educational careers occurs within the different curricular tracks, so that the educational system in Germany can meet the needs of all students, especially those with different abilities and with different goals. At this stage in the educational process, the diverse curricula are designed to prepare students either for higher education or for entrance into the workforce. As such, the different senior secondary schools offer a variety of coursework with specific goals: full-time general education, vocational education, and vocational training within the dual system (Altenstetter, 1995; *The Education System in Germany*, 2008).

In general, the different curricula stress preparation for vocational training (*Hauptschule*); preparation for employment in the middle levels of government, industry, and business *(Realschule*); preparation for higher education at the university level, through a demanding and in-depth education (*Gymnasium*); and preparation for a variety of futures with an all-inclusive curriculum (*Gesamtschule*) (Altenstetter, 1995; Solsten, 2005; *The Education System in Germany*, 2008). Because of this division, the German education system provides quality general education, as well as excellent specific training for a profession or skilled occupation through vocational training programs (Altenstetter, 1995). However, this division can be affected by the socioeconomic status of the parents, and thus, it can impact double jeopardy on mathematics achievement in German schools. Specifically, the socioeconomic status of the parents can affect the level of access to educational material and expectations for future occupations, which can then influence both the educational path and the academic achievement of students.

The extensive and diverse educational programs available to the students seem to promote quality education and achievement, while also reflecting the right to self-fulfillment for every German citizen (Altenstetter, 1995). This right to choose the type of education and occupation or profession to pursue is underscored by the educational policy, indicating that Germans receive education and training in line with their abilities and preferences (Altenstetter, 1995).

Principal Findings. As indicated in Chapter 4, all four school locations (rural areas, towns, cities, and metropolitan areas) in Germany exhibited adjusted double jeopardy effects. Moreover, adjusted double jeopardy effects were also evident for all four SES measures (father's SES, mother's SES, family occupation SES, and combined family SES), although the results differed according to the school location. The widespread nature of double jeopardy throughout Germany, in combination with the magnitude of the adjusted double jeopardy effects, indicates that the double jeopardy phenomenon was a very substantial and powerful factor in mathematics achievement. Thus, it is evident that socially disadvantaged students in Germany were seriously penalized by coming from both low-SES families and going to low-SES schools.

The double jeopardy results, however, were not uniform or consistent throughout the school locations or SES measures. Of the four SES measures, the most sensitive measure to double jeopardy in Germany was the combined family SES. This determination was made based on two criteria: 1) how widespread double jeopardy was for each of the SES measures across the four school locations; and 2) the amount of variance explained. The German metropolitan location was the most sensitive of the four school locations to the double jeopardy phenomenon, as it had the most widespread double jeopardy effects across the four SES measures and accounted for a reasonable amount of variance explained in each case.

Other characteristics of double jeopardy unique to Germany are as follows: 1) Germany had the most comprehensive (i.e., the largest and most widespread) double jeopardy results of all seven countries; 2) the double jeopardy results for the mother's SES were limited to the town and metropolitan locations; 3) double jeopardy in rural areas was limited to the father's SES and the combined family SES; 4) all four SES measures indicated double jeopardy effects in the town and metropolitan locations; 5) of the two family SES measures, the combined family SES indicated the most widespread occurrence of double jeopardy in all four school locations; and 6) the town location exhibited the largest double jeopardy effects associated with the mother's SES, the family occupation SES, and the combined family SES.

Italy

Background. In order to make sense of the double jeopardy results on mathematics achievement in Italy, influential socioeconomic factors at both the student level and school level are identified and discussed. Some of the most notable and potentially influential socioeconomic factors are population size and population distribution; however, other factors, such as unemployment and the educational system, are also influential in the life of people in Italy.

With a population of approximately 58,000,000 people in 2005, Italy has a proportionately large population for its size (World Populations Prospects Report, 2005). In fact, in 2003, Italy had the fifth-highest population density in Europe, approximately 490 people per square mile (*The World Factbook: Italy*, 2008). However, this population is not spread evenly throughout the country. An overwhelming majority of the Italian population, approximately 60 percent, resides in urban areas (cities and metropolitan areas), while only 30 percent reside in rural areas (*The World Factbook: Italy*, 2008). Moreover, 28 percent of the total population lives in the metropolitan areas of Milan (7.4 million), Rome (3.8 million), Naples (3.1 million), and Turin (2.4 million) (*The World Factbook: Italy*, 2008). This distribution of the population reflects a chasm between the rural and urban centers.

In 2004, the national unemployment rate in Italy was approximately 7.7 percent (Morgagni, n.d.). Although somewhat high, this unemployment rate is not indicative of the regional economic differences. In the industrialized North, the unemployment rate is fairly low, while in the less-developed South (primarily agricultural and welfare-dependent), there are unemployment rates of up to 20 percent, more than double the unemployment rates in the North (Morgagni, n.d.; *The World Factbook: Italy*, 2008). Thus, it is evident that the Italian economic system has two distinct parts characterized by the industrialized North and the less developed South, both of which influence the socioeconomic status of families, regionally and nationally (Morgagni, n.d.).

In 2003, education in Italy was compulsory for students ages 6 through 14, or through elementary school (5 years) and lower secondary school (3 years) ("Italy," 2007; *Italy*, 2002). However, education was not required in upper-secondary school (5 years). The required education primarily covers general knowledge and skills related to the cultural tradition and the social, cultural, and scientific evolution of contemporary society; it does not offer different curricula (*Italy*, 2008).

In contrast, upper-secondary education in Italy is divided into several different curricula (i.e., the sciences, the arts, technical training, and vocational training) (*Italy*, 2002). The different curricula include the following: a) classical programs, emphasizing the humanities with some science courses included; b) scientific programs, offering more specialized preparation in scientific subjects, with the last three years of the program devoted to scientific training; c) art education, preparing students for artistic work and production in either the figurative arts and stage design or in architecture; d) linguistic programs, focusing on the study of foreign languages, as well as courses in literature and civilization; and e) technical and vocational training (*Italy*, 2002; *Italy*, 2008). Only programs emphasizing the classics and the sciences aim at preparing students to attend universities, making these programs more in-depth and demanding (*Italy*, 2008). Meanwhile, because of the specialized focus of each technical and vocational program, these programs offer varying amounts of instruction in the general subjects, including mathematics.

Based on the design of the Italian education system, students who decide to continue their education in upper-secondary school must choose from a wide range of programs, including science education, art education, technical training, and vocational training. As a result, Italian students are exposed to differing amounts of general education subjects (i.e., mathematics), in addition to the more specialized topics unique to each program. When combined with the financial status of the family, the school, and the program of study (i.e., state funding), the curricular separation at the start of upper-secondary school affects each student's academic achievement and potentially influences double jeopardy in Italy.

In Italy, education is funded by the state, in order to provide equal educational opportunities for students. Specifically, the state is required to "remove financial or social obstacles which limit freedom and equality of citizens and, as a consequence, prevent the development of the human person and the real participation of all workers in the political, economic and social organisation of the country" (as cited in *Italy*, 2008). Because of this requirement, if the education is not free, the state provides scholarships, grants, school vouchers, and tax deductions, in order to "remove financial obstacles" that might prevent disadvantaged students from attending and graduating from upper-secondary schools, (*Italy*, 2008; "Italy," 2007).

Principal Findings. As indicated in Chapter 4, all four school locations (rural areas, towns, cities, and metropolitan areas) in Italy exhibited adjusted double jeopardy effects. However, only three of the four SES measures (mother's SES, family occupation SES, and combined family SES) displayed this double penalty on mathematics achievement. Although lacking double jeopardy effects associated with the father's SES, the widespread nature of double jeopardy associated with the remaining SES measures, in combination with the magnitude of the adjusted double jeopardy effects, indicates that the double jeopardy phenomenon was a very substantial and powerful factor in mathematics achievement in Italy. Thus, it is evident that socially disadvantaged students in Italy were seriously penalized by coming from both low-SES families and going to low-SES schools.

However, the double jeopardy results were not uniform or consistent among the school locations or SES measures. Of the four SES measures, the SES measure most sensitive to double jeopardy in Italy was the combined family SES. This determination was made based on two criteria: 1) how widespread double jeopardy was for each of the

SES measures across the four school locations; and 2) the amount of the variance explained. The town location was the most sensitive of the four school locations to the double jeopardy phenomenon in Italy, as it had the most widespread double jeopardy effects across the three SES measures (mother's SES, family occupation SES, and combined family SES) and accounted for a reasonable amount of variance explained in each case.

Other characteristics of double jeopardy unique to Italy are as follows: 1) there was no double jeopardy associated with the father's SES; 2) the double jeopardy results for the family occupation SES were limited to the rural region and the town location; 3) only the family occupation SES and the combined family SES exhibited double jeopardy in the rural region; 4) double jeopardy results for the city and metropolitan locations were limited to the mother's SES and the combined family SES; and 5) the most serious and most sensitive of the double jeopardy effects (i.e., the largest in magnitude and the highest percentage of total variance explained) for Italy occurred in the metropolitan location.

Japan

Background. In order to make sense of the double jeopardy results concerning mathematics achievement in Japan, influential socioeconomic factors at both the student level and school level are identified and discussed. Some of the most notable and potentially influential socioeconomic factors for the double jeopardy results in mathematics achievement in Japan are population size, population distribution, employment trends, unemployment rates, and the design of the educational system.

With a population of approximately 127,214,499 million people in 2003, Japan has an extremely large population for a country of its size (*The World Factbook: Japan*, 2009). In fact, according to the United Nations World Populations Prospects Report, as of July 2005, the population density in Japan was 339 persons per square kilometer (*World Populations Prospects Report, 2005*). However, this population is not spread evenly throughout the country. An overwhelming majority of the Japanese population, approximately 75 to 80 percent, resides in urban areas (cities and metropolitan areas), while only approximately 20 percent reside in rural areas (Dolan & Worden, 1994). Within this urban society, about 80 million of the urban population or 63 percent of the total population is heavily concentrated on the Pacific shore of Honshū. Furthermore, metropolitan Tokyo-Yokohama, with 35,000,000 people, is the most populous city in both Japan and the world (*World Populations Prospects Report, 2005*).

In addition to the most populous city, Japan also has the second largest economy in the world, after the United States (*The World Factbook: Japan*, 2009). In 2003, Japan employed 52.96 million people, an increase of 40,000 from the previous year (*Industrial relations in Japan 2003-4*, 2005). Of the approximately 66.7 million Japanese in the labor force in 2003, 41 percent lived in regions with an unemployment rate above the national average, which was approximately 5.3 percent (*Labour Market: Employment*, 2007; *The World Factbook: Japan*, 2009; *2008 World Economic Outlook*, 2009).

The Japanese education system utilizes a nationally-designed curriculum, so that all students are provided with a balanced, basic education. For the first nine years, through lower secondary school, school is compulsory and free. During this time, students are provided with equal educational treatment, and schools receive relatively equal distribution of financial resources (August, 1994). This equity is further underscored by long-standing cultural and philosophical beliefs embraced by the Japanese (August, 1994). Specifically, the Japanese believe that a) all children have the ability to learn the material; b) that effort, perseverance, and self-discipline, not academic ability, determine academic success; and c) that these study and behavioral habits can be taught. As a result, students in elementary and lower secondary schools are not grouped or taught on the basis of their ability, nor is instruction geared to individual differences (August, 1994).

However, these nine years of relatively equitable compulsory education are then followed by public or private upper-secondary school, which often displays highly divergent curricula, based on the type of high school: elite academic high schools, non-elite academic high schools, vocational high schools, and correspondence high schools (*Education in Japan,* 2007). With this divergence, Japanese students are essentially grouped according to ability, and thus set onto an appropriate career path. For example, the elite academic high schools accept the top of the student population, sending the majority of its graduates to the finest national universities (*Education in Japan,* 2007). Meanwhile, non-elite academic high schools prepare students for less prestigious universities or junior colleges, but often send many of their students to private specialist schools to learn book-keeping, languages and computer programming. Vocational high schools offer courses in commerce, technical subjects, agriculture, home science, nursing and fishery, with the purpose of preparing the majority of the students for full-time employment (*Education in Japan,* 2007).

It is evident that each type of high school has distinct objectives, which subsequently prepare students for particular destinations or roles in the society by employing curricula containing either general or highly specialized subjects (*Education in Japan,* 2007). As such, schooling is regarded as a preparation for appropriate positions in the workforce and for adult society by identifying students for leadership positions and others for subordinate positions. However, this societal differentiation through education, and the design of the education system, is influenced by the socioeconomic status of families.

Most Japanese believe that schooling offers an equal opportunity for all children to move up the social ladder if they are willing to work hard, since it is widely thought that selection to high schools is based solely on merit through achievement on entrance examinations (*Education in Japan,* 2007). However, merit is not the only variable that plays a role in securing entrance into certain high schools. Often the nature and rankings of the high schools correspond strongly to the relative wealth and privilege of the students. Thus, students with more privileged backgrounds, in terms of parental occupations and income, tend to concentrate at the higher-ranked schools, while those with less-privileged backgrounds congregate at lesser-ranked schools (*Education in Japan,* 2007).

The primary factor reflecting this socioeconomic influence is enrollment in private after-school study sessions, or cram schools (*Education in Japan,* 2007). According to *Education in Japan*, 90.8 percent of parents send their children to a cram school, with 65.2 percent of parents sending their children four or more days a week. Hence, the majority of students are placed in cram schools to prepare for the entrance examinations; however, the amount of time and money reserved for this purpose depends on both the wealth and standing of the family. Thus, the poorer students come into the exams already at a disadvantage, which can then influence the students' achievement. With this disadvantage, it is more likely for low-SES students to attend upper-secondary schools, where the nature and ranking correspond in part to the amount of time spent at a cram school, and thus, to achievement on the entrance exams.

Principal Findings. As indicated in Chapter 4, only the metropolitan school location in Japan exhibited adjusted double jeopardy effects. For this school location, only three of the four SES measures (mother's SES, family occupation SES, and combined family SES) exhibited a dual penalty on mathematics achievement. Although limited to the metropolitan location, the magnitude of the adjusted double jeopardy effects indicate that the double jeopardy phenomenon was a very substantial and powerful factor in mathematics achievement for the largest population centers in Japan. Thus, it is evident that socially disadvantaged students in metropolitan Japan were seriously penalized by coming from both low-SES families and going to low-SES schools.

However, the double jeopardy results were not uniform or consistent among the school locations or SES measures. Of the four SES measures, the most sensitive to double jeopardy in Japan was the combined family SES. This determination was made based on two criteria: 1) the magnitude of the double jeopardy effects for each of the SES measures in the metropolitan area; and 2) the amount of the variance explained in each double jeopardy model. Similarly, the metropolitan location was the most sensitive of the four school locations to the double jeopardy phenomenon in Japan, as it was the only location exhibiting double jeopardy effects.

Other characteristics of double jeopardy unique to Japan are as follows: 1) Japan had the least comprehensive (i.e., the least widespread) double jeopardy results of all seven countries, but the largest in magnitude; 2) double jeopardy was only evident in the metropolitan location; 3) no double jeopardy was evident for the father's SES; 4) the largest double jeopardy effects were associated with the family occupation SES; and 5) the combined family SES was the most sensitive to double jeopardy, given that it had the highest percentage of variance explained.

Russian Federation

Background. In order to make sense of the double jeopardy results on mathematics achievement in the Russian Federation, influential socioeconomic factors at both the student level and school level are identified and discussed. Two of the most notable factors in the Russian Federation are population size and population distribution; however, other factors, such as the rural culture, urbanization, poverty, and the design of the educational system (school funding and school curricula), are also influential in the life of people in the Russian Federation.

With a population of approximately 142.4 million people in 2006, the Russian Federation has the seventh largest population in the world (Curtis, 2006). However, due to the sheer size of the country – it is the largest country in the world – the population density is fairly low. Even so, the population is not spread evenly throughout the country. An overwhelming majority of the Russian population, approximately 73 percent, reside in urban areas: towns, cities, and metropolitan areas (Curtis, 2006). Only 27 percent of the population resides in rural areas (Curtis, 2006; Curtis & Leighton, 1996). Within this urban society, 10 percent of the population resides in the two largest cities: Moscow (10,126,424 people) and Saint Petersburg (4,661,219 people); while eleven other cities have between one and two million inhabitants: Chelyabinsk, Kazan, Novosibirsk, Nizhny Novgorod, Omsk, Perm, Rostov-on-Don, Samara, Ufa, Volgograd, and Yekaterinburg (Curtis, 2006).

Two main characteristics best describe the rural lifestyle in the Russian Federation: a) the focus and opportunities available, and b) the level of poverty. Unlike urban residents, rural residents typically remain centered in routines that have existed for generations, primarily those associated with agriculture, the main source of employment for rural societies in the Russian Federation (Curtis & Leighton, 1996). Meanwhile, inhabitants of urban centers are more focused on Western-oriented ideas and leisurely pursuits. In addition, the rural population has less money and benefits much less from the information exchange that characterizes urban centers (Curtis & Leighton, 1996).

Because of the primarily agricultural economy, rural workers tend to receive the least pay and the least opportunity for upward mobility (Curtis & Leighton, 1996). For this reason, rural areas are witnessing a large exodus of young people to urban centers, seeking a better life, and better education or technical training. Villages with fewer than 1,000 inhabitants have been disappearing at a rapid rate; the entire population of an estimated two-thirds of such villages have died or moved away between the years 1960 and 1995 (Curtis & Leighton, 1996). This urbanization of the Russian population has created difficulties in urban areas different from those faced by rural communities, such as a large separation between the economic levels of the urban population, increased stress on families, and greater differences in the kinds and levels of education available.

Unlike the problems facing urban areas, the problems facing rural areas originate from the ways in which the rural culture places the majority of students and their families on similar economic footing. The widespread agricultural work, the low-wages, the lack of upward social mobility, and the traditional beliefs and values of these rural communities have minimized the opportunities for individuals, families, and the community as a whole. Furthermore, the education received by rural students is increasingly inadequate because of a difficulty in retaining teachers and a homogeneous educational experience, which implies that these rural characteristics could influence how school location affects double jeopardy in the Russian Federation (Curtis & Leighton, 1996).

Meanwhile, urbanization within the Russian Federation has had serious consequences for families living in urban areas. Changes within the family unit (i.e., a reduction in size and increase in the number of divorces) impact both parental roles and the income of the family (Curtis & Leighton, 1996). Specifically, these changes have altered the family dynamics, and increasingly, more women are forced to bear both the domestic and economic burden for the family (Curtis & Leighton, 1996). Insufficient state child allowances, less economic support from men, and insufficient unemployment benefits have forced more women into the workforce. Now many women work outside the home, while still tending to the majority of the household chores (Curtis, 2006; Curtis & Leighton, 1996). In addition to this family dynamic, the percentage of single-parent families has increased. Because the majority of these families are headed by the mothers, who earn less and often work in substandard jobs, the families are often worse off economically (Curtis & Leighton, 1996). Thus, single-parent families, especially those headed by a female, are the most likely to be members of the working poor (Curtis & Leighton, 1996).

Furthermore, these economic hardships are reflective of the gap between the richest and poorest citizens of Russia (Curtis & Leighton, 1996). Although the percentage of the population below the poverty line has decreased from approximately 31 percent in the mid 1990s to 15 percent in 2006, the number of Russians needing some form of economic aid or welfare has increased to approximately 36 percent (Curtis, 2006; Curtis & McClave, 1996). This pervasive poverty and economic need among Russian citizens continues to expand along side the decline of the incomes of approximately 80 percent of Russians (Curtis, 2006). The declining incomes are connected primarily to the urban working class and agricultural workers. Thus, it is the working poor who constantly deal with additional deteriorating economic conditions, not the wealthy (Curtis & Leighton, 1996). Consequently, while those in poverty and with low incomes are the most negatively impacted by economic conditions, they are also the most likely to find urbanization to be detrimental to their families, incomes, and even the education of their children.

Although the state provides funds for preschool, basic, general and secondary vocational education in the public schools, it is insufficient for maintaining not only the current educational system, but also for implementing reforms (Curtis, 2006). Thus, there is a shortage of supplies (i.e., textbooks and computers), a decrease in qualified teachers, incomplete curriculum reform, and a deteriorating infrastructure (Curtis, 2006; Curtis &

Leighton, 1996). In addition, the schools are very large and overcrowded (Curtis & Leighton, 1996).

Because local authorities have the autonomy to determine both educational strategies and the curriculum, the quality and content of the curricula vary greatly among public schools in the Russian Federation (Curtis & Leighton, 1996). This diversity has resulted in the establishment of five types of secondary school: a) regular schools with a core curriculum; b) schools offering elective subjects; c) schools offering intensive study in elective subjects; d) schools designed to prepare students for entrance examinations to an institution of higher education; and e) alternative schools with experimental programs (Curtis & Leighton, 1996).

Principal Findings. As indicated in Chapter 4, only three of the four school locations (towns, cities, and metropolitan areas) in the Russian Federation exhibited adjusted double jeopardy effects. On the other hand, all four SES measures (father's SES, mother's SES, family occupation SES, and combined family SES) displayed this double penalty on mathematics achievement. This widespread nature of double jeopardy throughout the Russian Federation, in combination with the magnitude of the adjusted double jeopardy effects, indicates that the double jeopardy phenomenon was a very substantial and powerful factor in mathematics achievement. Thus, it is evident that socially disadvantaged students in the Russian Federation were seriously penalized by coming from both low-SES families and going to low-SES schools.

However, the double jeopardy results were not uniform or consistent throughout the school locations or SES measures. Of the four SES measures, the most sensitive measure to double jeopardy in the Russian Federation was the combined family SES. This determination was made based on two criteria: 1) how widespread double jeopardy was for each of the SES measures across the three school locations; and 2) the amount of the variance explained. The metropolitan location was the most sensitive of the four school locations to the double jeopardy phenomenon in the Russian Federation, as it had the most widespread double jeopardy effects across the four SES measures, and it accounted for a reasonable amount of variance explained in each case.

Other characteristics of double jeopardy unique to the Russian Federation are as follows: 1) no double jeopardy occurred in the rural region; 2) the double jeopardy results for the town location were limited to the family occupation SES and the combined family SES; 3) all four SES measures indicated double jeopardy effects in the city and metropolitan locations; 4) the town location exhibited the largest double jeopardy effects associated with the family occupation SES; and 5) the metropolitan location exhibited the largest double jeopardy effects associated with the father's SES and the combined family SES.

United Kingdom

Background. In order to make sense of the double jeopardy results on mathematics achievement in the United Kingdom, influential socioeconomic factors at both the student level and school level are identified and discussed. Two of the most notable factors for the United Kingdom are population size and population distribution; however, other factors, such as employment, unemployment, and the design of the educational system (structure and curriculum), are also influential to the life of people in the United Kingdom.

Although the United Kingdom had an overall population of approximately 59.8 million people in 2004, the distribution of this population across the four regions of the United Kingdom – England, Wales, Scotland, and Northern Ireland – varies drastically (*The Education System in England, Wales, Northern Ireland*, 2008). England, which is the most populated segment of the United Kingdom, accounts for nearly four-fifths of the population (50,093,000 million people), while Wales, Scotland, and Northern Ireland together account for only 2.95, 5.08, and 1.71 million residents, respectively (*The Education System in England, Wales, Northern Ireland*, 2008; Weisser & Kishlansky, 2008). As a result of England's significantly higher population, this region is also the most densely populated, with a population density of 384 persons per sq. km (Weisser & Kishlansky, 2008). In contrast, Scotland has the lowest population density, 64 persons per sq. km (Weisser & Kishlansky, 2008).

The above differences in the distribution of the population within the United Kingdom also extend to each separate region. For example, in Wales, two-thirds of the population resides in the industrial southern valleys (Weisser & Kishlansky, 2008). In Scotland, approximately 75 percent of the population resides in the central lowlands, near Glasgow, and near Edinburgh. In Northern Ireland, approximately half of the people live in the eastern portion, in Belfast, and along the coast (Weisser & Kishlansky, 2008). Within these three regions, it is evident that the population is not distributed evenly; however, the largest discrepancy occurs in England, where the vast majority (89 percent) of the population reside in and around urban areas such as London, Birmingham, Leeds, Sheffield, and Manchester (Weisser & Kishlansky, 2008). In short, the United Kingdom is primarily urban, with only a small portion of the British population still residing in rural areas (Weisser & Kishlansky, 2008).

As the fifth-largest economy in the world, the United Kingdom has a large labor force and one of the lowest unemployment rates (*U.S. Department of State background note: United Kingdom*, 2008; *United Kingdom: Economy*, 2008). The labor force in the United Kingdom consisted of 29,648,000 people in 2003 and 29,821,000 people in 2004 (*Comparative Civilian Labor Force Statistics, 10 Countries, 1960-2004*, 2005). Of the four regions of the United Kingdom, the highest employment rates for 2003 and 2004 were attributed to England, at approximately 75 percent (*Employment Rate,* 2008). Similarly, Scotland had employment rates between 74 and 75 percent for 2003 and 2004, while Wales had employment rates between 71 and 73 percent (*Employment Rate*, 2008). Only Northern Ireland had an employment rate that ranged from 70 to 66 percent during the allotted two year period (*Employment Rate*, 2008).

By 2004, the United Kingdom had an unemployment rate of approximately 4.8 percent (*The Education System in England, Wales, Northern Ireland*, 2008; *Comparative Civilian Labor Force Statistics, 10 Countries, 1960-2004*, 2005). However, the rates of unemployment varied between the four regions of the country: England (4.7%), Wales (4.6%), Scotland (6.1%), and Northern Ireland (3%) (*The Education System in England, Wales, Northern Ireland*, 2008; *Northern Ireland Labor Force Survey: Spring (Mar-May 2004),* 2004).

In general, the United Kingdom is a generous, well-educated, and tolerant society; however, tension can be found between those in poverty and those with higher social status (the elite upper class, the lower upper class, the middle class, and the working class) (Weisser & Kishlansky, 2008). One of the primary reasons for this tension is that the permanent underclass, or those in poverty, has little hope of upward social mobility (Weisser & Kishlansky, 2008). For approximately 17 percent of the population (2002), life is a cycle of poverty, in which the people live in poor surroundings, have a limited education, and subsist on welfare (*United Kingdom: Economy*, 2008; Weisser & Kishlansky, 2008). These factors, when combined with the neglected and squalid neighborhoods in urban areas, where the majority of this segment of the population reside, magnify the inherent inequalities within the class structure in the United Kingdom and the difficulties associated with individual and family advancement (Weisser & Kishlansky, 2008).

For a period of 12 years, education is both free and compulsory, typically lasting from the age of 5 to the age 16 (ages 4-16 in Northern Ireland) (*U.S. Department of State Background Note: United Kingdom*, 2008; Weisser & Kishlansky, 2008; *United Kingdom*, 2008b). During this time, students attend several different educational levels: primary schools (ages 5-11), or basic first stage (ages 5-7) and basic second stage (ages 7-11) schools; secondary schools (ages 11-16); and post-compulsory education (ages 16-18+) (*United Kingdom,* 2008b; *The Education System in England, Wales, Northern Ireland*, 2008; *Scotland (United Kingdom),* 2008).

Although this structure could affect the educational outcomes of students in the United Kingdom, discrepancies or differences in the education of students rest primarily at the secondary-school level. At this level, the United Kingdom utilizes a wide variety of secondary schools (i.e., comprehensive, secondary, academic secondary or grammar, and technical schools), focusing on different curricula and goals; thus, providing a variety of opportunities and academic preparation for the students (Weisser & Kishlansky, 2008). In particular, comprehensive schools include students of all academic abilities and provide a multitude of programs and curricula, while secondary schools provide vocational education (Weisser & Kishlansky, 2008). Academic secondary schools, or grammar schools, prepare students for entrance into higher education, while technical schools provide technical education (Weisser & Kishlansky, 2008; *United Kingdom*, 2008b).

Each of these schools cater to different students and focus on specific programs; however, all of the students follow a common curriculum, designed to provide a broad general education consistent with the national (or local) curriculum of each region, while also emphasizing common concepts and values in addition to core subjects (i.e., mathematics, science, and history) (*The Education System in England, Wales, Northern Ireland*, 2008). Some of those common principles include the concept that education in the United Kingdom should "promote the spiritual, moral, cultural, mental and physical development of pupils at the school and of society" and "prepare pupils for the opportunities, responsibilities and experiences of later life" (as cited in *The Education System in England, Wales, Northern Ireland*, 2008). Because of this emphasis, courses for vocational training, higher education, or for specific subject areas (i.e., technology or the arts) are also available so that students may focus on their individual goals and needs.

Principal Findings. As indicated in Chapter 4, all four school locations (rural areas, towns, cities, and metropolitan areas) in the United Kingdom exhibited adjusted double jeopardy effects. Moreover, adjusted double jeopardy effects were also evident for all four SES measures (father's SES, mother's SES, family occupation SES, and combined family SES), although the results differed according to the school location. The widespread nature of double jeopardy throughout the United Kingdom, in combination with the magnitude of the adjusted double jeopardy effects, indicates that the double jeopardy phenomenon was a very substantial and powerful factor in mathematics achievement. Thus, it is evident that socially disadvantaged students in the United Kingdom were seriously penalized by coming from both low-SES families and going to low-SES schools.

However, the double jeopardy results were not uniform or consistent throughout the school locations or SES measures. Of the four SES measures, the most sensitive SES measure to double jeopardy in United Kingdom was the combined family SES. This determination was made based on two criteria: 1) how widespread double jeopardy was for each of the SES measures across the four school locations; and 2) the amount of the variance explained. The town location was the most sensitive of the four school locations to the double jeopardy phenomenon in the United Kingdom, as it had the most widespread double jeopardy effects across the four SES measures, and it accounted for a reasonable amount of variance explained in each case.

Other characteristics of double jeopardy unique to the United Kingdom are as follows: 1) after Germany, the United Kingdom had the most comprehensive (i.e., the largest and most widespread) double jeopardy results; 2) only the United Kingdom found mother's SES to be an important indicator of double jeopardy in the rural region; 3) the double jeopardy results for the metropolitan location were limited to the combined family

SES; 4) all four SES measures indicated double jeopardy effects in the rural region, town, and city locations; and 5) the town location exhibited the largest double jeopardy effects associated with all four SES measures, while the rural region exhibited the smallest double jeopardy effects for all four SES measures.

United States

Background. In order to make sense of the double jeopardy results on mathematics achievement in the United States, influential socioeconomic factors at both the student level and school level are identified and discussed. Two of the most notable factors for the United States are population size and population distribution; however, other factors, such as unemployment, the social structure, and the design of the educational system (i.e., age for compulsory education, the educational structure, the curriculum, and the concept of accountability), are also influential in the life of people in the United States.

In 2003, the population of the United States was estimated to be approximately 293,907,000 people (U.S. Census Bureau, 2005). However, according to the 2000 census, the population distribution between each region, and across the fifty states, was not equal. The Northeast had the lowest population of the four regions at 53,594,378 people, while the populations of the Midwest and West regions of the country were similar at 64,392,776 people and 63,197,932 people, respectively (Perry & Mackun, 2008). In contrast, the South had the largest population with 100,236,820 people (Perry & Mackun, 2008). Furthermore, the distribution between rural and urban areas also varied drastically. According to the Population Reference Bureau, by 2001, 77 percent of the population lived in urban areas. Only 23 percent resided in rural areas (Population Reference Bureau [PRB], 2009). In addition, the ten most populous states contain 54 percent of the population, while the ten least populous states account for only 3 percent of the total population of the United States (Perry & Mackun, 2008).

The United States is the largest and most technologically powerful economy in the world, with a labor force of 146,510,000 people, aged 16 and older, in 2003 (*Comparative Civilian Labor Force Statistics, 10 Countries, 1960-2004*, 2005; *Labor force statistics from the Current Population Survey*, 2003; *The World Factbook: United States*, 2008; *The U.S. Economy*, 2008; "United States Economy," 2008). Of this number, approximately 6 percent were unemployed in 2003, a relatively low number for developed nations. By region, the Midwest had the lowest unemployment rate, 5.3 percent, while the West had the highest unemployment rate, 6.2 percent (*Regional and State Employment and Unemployment: January 2003*, 2003).

Because the social class stratification evident in the United States is based primarily on socioeconomic status, the most basic attributes of each social group in the social structure are determined by education, occupation, and income (Keel, 2008). There are six distinct levels of the class structure in the United States: the upper (capitalist) class, the upper-middle class, the lower-middle class, the working class, the working poor, and the underclass (below the poverty level) (Keel, 2008). In this social structure, those with a higher and more prestigious education are more likely to be of higher social class (upper and upper-middle classes), and those with little or no education often fall into the working poor or the permanent underclass (Keel, 2008). In contrast, the middle classes (lower-middle class and working class) have more mobility, and the social placement often reflects their chosen occupation, though the division primarily lies along socioeconomic lines.

Like the social structure, the education system is an important factor to understanding double jeopardy in the United States. Specifically, the age for compulsory education, the educational structure, the curriculum, and the concept of accountability are components of the education system that potentially affect the double jeopardy results. Although the age for mandatory schooling varies by state, all states require children to attend school and receive at least 11 years of education (*U.S. Education*, 2008; *Organization of U.S. Education*, 2008). In most states, mandatory education begins in kindergarten at the age of 5 (or 6) and ends between the ages of 16 and 18 (*USA Education System: Overview of the American Education System*, 2007; *U.S. Education*, 2008; *United States of America*, 2008; *United States*, 2008). Even with the differences by state, a high percentage of students remain in school through the end of secondary school, at the age of 18.

Similar to the generalities in compulsory education, an overall education structure can be identified for the United States. In most states, the educational structure has five levels: pre-primary school (ages 4-6); primary or elementary schools (ages 6-11); lower-secondary schools or middle schools (ages 11-14); secondary schools or high schools (ages 14-18); and post-secondary education (*Organization of U.S. Education,* 2008). Within this educational structure, the students are divided by age groups into grades, beginning in kindergarten and culminating in the 12th grade. Primary education, which ranges from grade 1 to grades 4-7, depending on state, most typically includes grades 1 to 5 (*USA Education System*, 2008; *USA Education System: Overview of the American*

Education System, 2007; *Organization of U.S. Education*, 2008; *United States of America*, 2008; *United States*, 2008). Meanwhile, lower-secondary school incorporates grades 6-8 for students, aged 11 to 14, and upper-secondary school typically lasts for four years (grades 9 to 12), and enrolls students between the ages of 14 and 18 (*U.S. Education*, 2008).

Although this structure could affect the educational outcomes of students in the United States, differences in the education of students rests primarily at the secondary-school level, where students often follow different curricular tracks (i.e., honors, academic or college preparatory, vocational, and general education) (*USA Education System*, 2008). At this level, schools in the United States allow students more freedom to choose the subject areas and the level of difficulty of the courses beyond the basic curricular requirements, which are set by the state. Thus, although the curriculum remains fairly general, without emphasis in a particular subject, the students take a wide range of elective classes, which separate them into diverse educational tracks and provide them with a variety of educational opportunities (*United States*, 2008).

One additional component or characteristic of education in the United States is the importance of accountability or assessment. Within the United States, standardized testing is used to ensure that all students in public schools receive a certain level of minimum education (*Executive Summary of the No Child Left Behind Act of 2001*, 2001). This dependence on assessment and accountability is often connected to the difference in the quality of education available to students in the United States, and it is a result of the amount and level of achievement in American schools (*USA Education System: Overview of the American Education System,* 2007). In particular, because students from the United

States have ranked below other developed countries in their science and mathematics understanding for years, assessment and accountability have become even more instrumental to the current state of the educational system in the United States (NCES, 2005).

Principal Findings. As indicated in Chapter 4, all four school locations (rural areas, towns, cities, and metropolitan areas) in the United States exhibited adjusted double jeopardy effects. Furthermore, all four SES measures (father's SES, mother's SES, family occupation SES, and combined family SES) also displayed this double penalty in mathematics achievement. The widespread nature of double jeopardy throughout the United States, in combination with the magnitude of the adjusted double jeopardy effects, indicates that the double jeopardy phenomenon was a substantial and powerful factor in mathematics achievement. Thus, it is evident that socially disadvantaged students in the United States were seriously penalized by coming from both low-SES families and going to low-SES schools.

However, the double jeopardy results were not uniform or consistent among school locations or SES measures. Of the four SES measures, the most sensitive SES measure to double jeopardy in United States was the father's SES. This determination was made based on two criteria: 1) how widespread double jeopardy was for each of the SES measures across the four school locations; and 2) the amount of the variance explained. The metropolitan location was the most sensitive of the four school locations to the double jeopardy phenomenon in the United States, as it had the most widespread double jeopardy effects across the four SES measures, and it accounted for a reasonable amount of variance explained in each case.

Other characteristics of double jeopardy unique to the United States are as follows: 1) although the father's SES exhibited the most extensive occurrence of this double penalty on mathematics achievement in the United States, it was not significant in the rural region; 2) double jeopardy in the rural region was limited to the combined family SES; 3) double jeopardy in the city location was limited to the father's SES; 4) all four SES measures indicated double jeopardy effects in the town and metropolitan locations; 5) with the exception of the father's SES in the city location, all of the double jeopardy effects were large, and they accounted for a reasonable proportion of the total variance in mathematics achievement; and 6) the town location exhibited the largest double jeopardy effects associated with the mother's SES, family occupation SES, and combined family SES.

Comparative Syntheses

The previous section detailed the principal findings for double jeopardy in seven of the G8 countries. This section considers a cross-country perspective for the double jeopardy results. Thus, the principal findings for each country are discussed in light of similarities and differences between and across the seven countries included in this study. This discussion identifies the countries with the most (or least) comprehensive double jeopardy and those with the strongest (or weakest) double jeopardy. The sensitivity, measured through the proportion of variance explained in mathematics achievement, and the seriousness of the double jeopardy results, measured through the magnitude of double jeopardy effects, are also discussed through this cross-country perspective. Furthermore, similar patterns and unique characteristics will be discussed, according to school location and SES measure.

In general, each country exhibited double jeopardy effects, which were primarily large, and which accounted for an adequate percentage of the total variance. However, as established in Chapter 4, the results varied by school location and SES measure, both within and across the seven countries. Of the seven countries, Germany showed the most comprehensive (i.e., the most widespread and largest) double jeopardy results, although the double jeopardy results from the United Kingdom were similar. In contrast, Japan had the least comprehensive double jeopardy results, with only the metropolitan location exhibiting double jeopardy. Although Japan had the least comprehensive double jeopardy, with effect sizes between 178 and 254 score points, the double jeopardy results were also the largest in magnitude among all seven countries, which indicates that Japan had the strongest double jeopardy. Canada, on the other hand, exhibited the weakest double jeopardy results, with effect sizes ranging from 41 to 89 score points.

School Location. In order to better examine the similarities and differences in the double jeopardy results across countries, the double jeopardy results were broken down first by school location and then by SES measure. In terms of school location, the results of the adjusted double jeopardy models for G8 countries indicated that there was no single commonality between the SES measures exhibiting the double jeopardy phenomenon in any of the four school locations. However, this study found double jeopardy evidence in all four school locations in Canada, Germany, Italy, the United Kingdom, and the United States. In contrast, double jeopardy was evident in three school locations in the Russian Federation, and it was evident in only one school location in Japan. Aside from Japan, which has unique double jeopardy results, the results from the Russian Federation differed primarily in the rural region, where double jeopardy was not in evidence.

In the rural region, several similarities and differences exist. First, the occurrence of double jeopardy differed across countries. Neither in Japan nor in the Russian Federation was there any evidence of a double jeopardy effect for any SES measure. The United States only exhibited double jeopardy associated with the combined family SES, and Italy only demonstrated double jeopardy for the family occupation SES and the combined family SES. Furthermore, only double jeopardy associated with the father's SES was evident in Canada, while the United Kingdom was the only country with double jeopardy associated with all four SES measures, especially the mother's SES. Second, neither the sensitivity – measured through the proportion of variance explained in mathematics achievement – nor the seriousness of the double jeopardy results – measured through the magnitude of double jeopardy effects – was consistent across countries. For Italy, in terms of effect size and percentage of total variance explained, double jeopardy was the largest and most sensitive of the seven countries. This was similar to the case in Germany. Although widespread, double jeopardy in the United Kingdom was not as large or as sensitive as in Italy; however, the results were closer in nature to those of the United States. Only Canada exhibited moderate effect sizes in the rural region, indicating that this school location in Canada was the least sensitive to double jeopardy, after Japan and the Russian Federation.

Unlike the rural region, the town location indicated more similarities between countries. In Canada, Germany, the United Kingdom, and the United States each SES measure (father's SES, mother's SES, family occupation SES, and the combined family SES) exhibited a double jeopardy effect for the town location. Even Italy and the Russian Federation indicated double jeopardy effects; only Japan did not. However, the sensitivity and seriousness of double jeopardy by country did differ. Germany and the United States were similar, in that they both indicated large double jeopardy effects with high percentages of the total variance explained, indicating sensitivity. However, the results were higher in both areas in Germany. In contrast, both Canada and the Russian Federation had remarkably lower effect sizes associated with double jeopardy, indicating that double jeopardy in both countries was not as serious.

In general, the double jeopardy results for the city location were very similar to the town location. In particular, in Canada, the Russian Federation, and the United Kingdom each of the four SES measures exhibited a double jeopardy effect in the city location. Furthermore, once again, Japan did not show any indication of double jeopardy. However, one unique difference was evident: the only double jeopardy present in the United States was associated with the father's SES. In terms of effect size and percentage of total variance explained, which indicated sensitivity, double jeopardy in Germany was the largest and most sensitive of the seven countries, while Canada and the Russian Federation were smaller and very similar. Only the United States exhibited moderate effect sizes in the city location, indicating that the United States was the least sensitive to double jeopardy after Japan.

The metropolitan location is the only school location were all seven countries exhibited the double jeopardy phenomenon. Similar to the town and city locations, several countries indicated a double jeopardy effect for each of the four SES measures: Germany, the Russian Federation, and the United States. However, one unique difference was present: the only double jeopardy evident in the United Kingdom was associated with the combined family SES. In terms of effect size, Japan had the largest double jeopardy of the seven countries; however, the most sensitive country to double jeopardy was Italy, which had the highest percentage of total variance explained. Both Canada and the Russian Federation were similar in effect size and sensitivity; however, Canada had the smallest double jeopardy effects and was the least sensitive.

Based on the above similarities and differences, the rural region had the most unique results of the four school locations. In particular, only one country (the United Kingdom) exhibited double jeopardy for all four SES measures. Also, both Japan and the Russian Federation did not indicate double jeopardy results, a unique occurrence for the Russian Federation. Overall, in terms of school location, Germany appeared to be the country with the most consistent and strong double jeopardy results, while double jeopardy in Japan was limited to the metropolitan location. In terms of the G8 countries, the school location represented the most concern is the metropolitan location, while the rural region represented the least concern for double jeopardy on a global scale.

SES Measures. Along with the interest in the influence of school location on any double jeopardy effects, this study also examined the effects, according to the type of SES measure utilized in the analysis: father's SES, mother's SES, family occupation SES, and combined family SES. As such, the cross country results have been divided according to each of the four SES measures. Similar to school location, the results of the adjusted double jeopardy models for G8 countries indicated that there was no single commonality among the countries. However, this study found double jeopardy associated with all four SES measures in Canada, Germany, the Russian Federation, the United Kingdom, and the United States. In contrast, double jeopardy was evident for three SES measures in Italy and Japan. In both of these countries, double jeopardy associated with the father's SES was lacking.

For the father's SES, several similarities and differences exist. First, the occurrence of double jeopardy differed across countries. Neither in Italy nor in Japan was there any evidence of a double jeopardy effect for the father's SES measure in any school location. In contrast, both Canada and Germany exhibited double jeopardy effects associated with the father's SES in all four school locations. There was a lack of evidence in Russian Federation, the United Kingdom, and the United States for double jeopardy associated with the father's SES in the town, metropolitan, and rural school locations, respectively. With the exception of Italy and Japan, the seven G8 countries in this study indicated a double jeopardy effect for the father's SES within the city location. In terms of effect size and percentage of total variance explained, which indicates sensitivity, double jeopardy associated with the father's SES in Germany was the largest and most sensitive of the seven countries, followed closely by double jeopardy in the United States. Canada exhibited the smallest effect sizes for the father's SES, indicating that Canada was the least sensitive to double jeopardy, after Italy and Japan.

For the mother's SES, although double jeopardy was evident for all of the seven G8 countries in this study, the occurrence differed across school locations. One noticeable similarity exists, however: no country exhibited double jeopardy effects associated with the mother's SES for all four school locations. Only Italy and the United Kingdom indicated double jeopardy effects for three of the school locations. With the exception of Japan, the remaining countries all exhibited double jeopardy effects associated with the mother's SES in two school locations. Furthermore, only the United Kingdom indicated double jeopardy for the mother's SES in the rural region, while only Canada and the United Kingdom lacked the double jeopardy effects in metropolitan areas. In terms of effect size, Japan had the largest double jeopardy associated with the mother's SES; however, the most sensitive country to this double jeopardy was Germany, which had the highest percentage of total variance explained, indicating sensitivity. Both Canada and the Russian Federation were similar in effect size and sensitivity; however, the Russian Federation had the smallest double jeopardy effects associated with the mother's SES, and it was the least sensitive.

Similar to the double jeopardy results associated with the mother's SES, the double jeopardy results associated with the family occupation SES indicated that double jeopardy was evident for all of the G8 countries in this study. However, no country exhibited double jeopardy effects associated with the family occupation SES for all four school locations. Canada, Germany, the Russian Federation, and the United Kingdom indicated double jeopardy effects for three of the school locations. With the exception of Japan, all the G8 countries exhibited double jeopardy effects associated with the family occupation SES in the town location. In contrast, only in Italy and the United Kingdom was the family occupation SES an important indicator of double jeopardy in the rural region, but not in the metropolitan location. In terms of effect size, Japan had the largest double jeopardy associated with the family occupation SES; however, the most sensitive country to this double jeopardy was Germany, which had the highest percentage of total variance explained, indicating sensitivity. Similarly, the Russian Federation had the smallest effect sizes, making these double jeopardy effects the weakest. Canada was the country least sensitive to double jeopardy associated with the family occupation SES.

The double jeopardy results associated with the combined family SES indicated that double jeopardy was evident for all of the G8 countries in this study. Only Germany, Italy, and the United Kingdom exhibited double jeopardy effects associated with the combined family SES for all four school locations. The Russian Federation and the United States indicated double jeopardy effects for three of the school locations. In addition, all the countries, except Canada, evinced double jeopardy effects for the combined family SES in metropolitan areas. Similarly, all the G8 countries, with the exception of Japan, indicated a double jeopardy effect for this SES measure in the town location. In terms of effect size, Japan had the largest double jeopardy associated with the combined family SES; however, the most sensitive country to this double jeopardy was Germany, which had the highest percentage of total variance explained, indicating sensitivity. Canada exhibited the smallest effect sizes and accounted for the smallest percentage of total variance (i.e., the sensitivity) for the combined family SES, indicating that Canada was the country least sensitive to double jeopardy.

Based on the above similarities and differences, the father's SES had the most unique results of the four SES measures. In particular, the father's SES was the only SES measure not to exhibit double jeopardy in each of the G8 countries in this study; for instance, no double jeopardy was associated with the father's SES in Italy and Japan.

While Japan typically indicated the strongest double jeopardy results for three of the SES measures, it was not the most sensitive country to double jeopardy. Overall, Germany appeared to be the country with the most consistent and strongest double jeopardy results, while Canada and the Russian Federation were often the smallest and weakest, in terms of double jeopardy associated with the different SES measures. In general, the combined family SES appeared to be the best indicator of double jeopardy for the G8 countries, followed by the father's SES, while the mother's SES and the family occupation SES were the worst indicators of double jeopardy on a global scale.

Summary. Double jeopardy is a diverse phenomenon, affecting disadvantaged students throughout the G8 countries. However, some specific conclusions can be made from this study, concerning the patterns and similarities between countries, school location, and SES measures. First, to reiterate, the country exhibiting the most comprehensive double jeopardy results is Germany. Germany consistently exhibited three characteristics: 1) the most widespread double jeopardy effects, 2) large double jeopardy effects, and 3) a high percentage of variance explained (sensitivity). In contrast, Japan had the least comprehensive and most unique double jeopardy results of all the G8 countries. Only for Japan were the double jeopardy results limited to one school location: metropolitan areas. Although limited in results, the double jeopardy effects for Japan were the largest of the entire study. Furthermore, Japan lacked any double jeopardy associated with the father's SES. Italy also lacked double jeopardy associated with the father's SES, indicating a similarity with Japan. Although Japan had the strongest double jeopardy effects in this study, the United Kingdom tended to have the weakest, with the smallest double jeopardy effect sizes on the whole.

Other similarities are evident between the remaining countries. First, double jeopardy was evident for all the SES measures in two of the three larger school locations: towns, cities, and metropolitan areas. However, the exact combination differed. Other than the United Kingdom, none of the other G8 countries indicated universal double jeopardy effects in rural regions. Second, with the exception of the United States in the city location, double jeopardy in rural regions was the smallest (i.e., in effect size) and the weakest (i.e., accounted for the smallest percentage of total variance) of all the school locations. In contrast, no pattern exists for school locations that exhibited either the strongest or the largest double jeopardy; however, in most countries these two characteristics of double jeopardy often did not occur in the same school location. According to these results, it can be concluded that double jeopardy was limited in rural regions, but was often found among larger populations.

Third, for all of the G8 countries, the two family SES measures, family occupation SES and combined family SES, appear to illustrate the double jeopardy phenomenon more universally. In general, the results for Canada and the Russian Federation were more similar in the widespread nature of double jeopardy, the size of the double jeopardy effects, and the sensitivity of double jeopardy for the country as a whole. In other words, only Canada and the Russian Federation demonstrated remarkably lower double jeopardy effects, as well as lower sensitivity to double jeopardy. The results for Germany and the United States were also very similar to one another. In particular, each country exhibited higher double jeopardy effects and more sensitivity to double jeopardy. In contrast, the United Kingdom was similar to Canada and the Russian Federation in effect size, but closer to Germany and the United States in sensitivity to double jeopardy.

Aside from the similarities previously described for Italy and Japan, concerning the metropolitan location and the father's SES, the results for Italy more closely resemble those of Germany and the United States. Only the results for Japan remain unique; however, the Russian Federation was similar to Japan in that the results did not exhibit double jeopardy in the rural region, a unique result among the G8 countries.

Another aspect of this study has been to determine which SES measure and school location is the most sensitive to double jeopardy in each of the respective countries. For Germany, Italy, Japan, the Russian Federation, and the United Kingdom, the combined family SES was the most sensitive SES measure to the double jeopardy phenomenon. Meanwhile, Canada and the United States found the father's SES to be the most sensitive to double jeopardy. Based on these results, the combined family SES was the best indicator of double jeopardy across the G8 countries, followed by the father's SES. This could mean that the use of mother's SES and a family SES, based on occupation, is not as decisive or informative as other measures of socioeconomic status. Furthermore, a connection, whether cultural or economic, could be the basis for the results from Canada and the United States, as these two countries share a border and similar histories.

In terms of school location, the most sensitive school location across the G8 countries appears to be metropolitan areas. In Germany, Japan, the Russian Federation, the United Kingdom, and the United States, metropolitan areas were the most sensitive to double jeopardy in their respective countries. The city location was the most sensitive to double jeopardy in Canada, while the town location was the most sensitive to double jeopardy in Italy. However, even in Italy, the results concerning the metropolitan location cannot be dismissed in their importance. Based on these results, metropolitan areas are the most likely school location to be susceptible to double jeopardy across the G8 countries; thus, this school location might be a likely starting point for policy changes, although any changes should be specific to each particular country.

Contributions to the Literature

This section will address how this study contributes to the literature on the impact of socioeconomic status on mathematics achievement. It will describe a) how double jeopardy effects were widespread across both SES measure and school location, b) how sensitivity to double jeopardy depends on the SES measure, and c) how sensitivity to double jeopardy depends on the school location.

As previously discussed, the literature indicates substantial and stable SES effects on academic achievement. In fact, the socioeconomic impact on achievement has been consistent in the literature for the past five decades. During this time, most studies have focused on either the student-level SES or the school-level SES. In addition, a variety of definitions for SES were used interchangeably. Even so, the vast majority of studies have found SES to be a powerful indicator of achievement, especially mathematics achievement.

Only recently have studies begun to look at SES in a different light. In particular, Ma and Dundas (2009) examined mathematics achievement in the United States through the simultaneous consideration of student- and school-level SES, or through double jeopardy. Three SES measures were utilized to determine the best definition of SES to use in the study of mathematics achievement: father's SES, mother's SES, and family

SES. Although this study indicates that dual penalties were very real for socially disadvantaged students in the learning of mathematics in the United States, the double jeopardy effects were not the same for each SES measure. Specifically, the mother's SES did not exhibit any statistically significant double jeopardy effects. On the other hand, both the father's SES and the family SES exhibited large double jeopardy effects, and accounted for a reasonable proportion of the total variance in mathematics achievement in each case.

Unlike the study by Ma and Dundas (2009), this study on double jeopardy in mathematics achievement in the G8 countries is more comprehensive because it examines the phenomenon across seven countries. Moreover, an additional SES measure (combined family SES) has also been included, which better corresponds to the traditional definition utilized in the literature. As such, this study adds a substantial model to the literature, providing a foundation for a new perspective or outlook on socioeconomic status. It also bridges the new model to the previous literature on the subject.

In addition, the results of this study overwhelmingly support the research literature: socioeconomic status impacts mathematics achievement. According to this study, double jeopardy effects were widespread across SES measure and school location in six of the G8 countries examined, with only Japan showing unique results. More importantly, even after controlling student and school characteristics, the double jeopardy effects remained strong and widespread. Thus, the treatment of socioeconomic status through the double jeopardy model both supports the literature and provides a new direction for future research, so that researchers and policy makers can better understand how SES impacts academic achievement.

Furthermore, this study also provides insight into how the definition of SES can impact the results of a study. By examining four SES measures, this study was able to determine the effectiveness of various definitions. In general, this study found that the combined family SES was the most sensitive of the four SES measures to double jeopardy, when applied to the seven countries examined in this study: Germany, Italy, Japan, the Russian Federation, and the United Kingdom. Only for Canada and the United States was the father's SES the most sensitive SES measure to double jeopardy. Thus, these results support the most common definition of SES in the literature, and the results provide researchers with a proven choice for SES application in their research.

Like Ma and Dundas (2009), this study also examined the phenomenon of double jeopardy across four school locations: rural areas, towns, cities, and metropolitan areas; however, because this study encompasses seven countries, the results can be generalized to better understand the effect of SES on different populations. Although double jeopardy results were widespread across the four school locations, this study found the metropolitan location to be the most sensitive of the four school locations to double jeopardy in Germany, Japan, the Russian Federation, the United Kingdom, and the United States. Only for Canada and Italy were the most sensitive school locations cities and towns, respectively. These results give researchers, educators, and policymakers a better focus for further study and for the implementation of programs and policies designed to aid disadvantaged students.

Policy Implications

Based on the results of this study, double jeopardy appears to be a serious concern globally, for the G8 countries, based on two indicators: (a) the magnitude of double jeopardy effects, and (b) the widespread nature of the double jeopardy results. It seems that all the G8 countries, with the exception of France, which could not be included in this study, face a similar challenge in reducing double jeopardy effects. As such, collaborations among G8 countries appear to have more than economic benefits – social benefits are also possible through collaborations on this shared challenge. Because collaborations promote learning from one another, interventions aimed at fighting the low achievement of low-income students can provide helpful insight into current or future programs designed to fight double jeopardy throughout the G8 countries. Two examples of interventions that suggest such possibilities are as follows.

In the United States, the Head Start program is a federal initiative "promoting school readiness by enhancing the social and cognitive development of [economically disadvantaged] children through the provision of educational, health, nutritional, social and other services" (as cited in Office of Head Start, 2009). The Head Start program also focuses on helping preschoolers develop the early reading and math skills needed to succeed in school (Office of Head Start, 2009). In order to examine the effectiveness of this intervention, the United States government has initiated the National Head Start Impact Study, a longitudinal study designed to determine how Head Start affects the school-readiness of children participating in the program, as compared to children not enrolled in it (Office of Head Start, 2009). The second goal of the study is to determine the optimal conditions for Head Start, as well as for which children this initiative works best (Office of Head Start, 2009). Initial examination of the Head Start program shows benefit to disadvantaged students as they begin their school careers.

A similar example of intervention is the Sure Start program in the United Kingdom. This program, which was initiated in 2003, is a network of children's centers that offer integrated early childhood education, childcare, and family support and health services (*The Education System in England, Wales, Northern Ireland,* 2008). Although initially established in disadvantaged and low-income areas, the ultimate goal is for the program to be available in every community by 2010 (*The Education System in England, Wales, Northern Ireland,* 2008). Like the Head Start program in the United States, the Sure Start program is designed to ensure that all children receive the best academic foundation before entering primary school (i.e., kindergarten), especially concerning reading and mathematics (*The Education System in England, Wales, Northern Ireland,* 2008). There have also been additional programs, such as the extended school program that works with Sure Start to incorporate the ideas and goals of the program into a more long-term approach. This program aims to raise standards and further academic achievement of students through integrated support, in order to meet the needs of disadvantaged families (*The Education System in England, Wales, Northern Ireland,* 2008).

In addition to learning from interventions utilized in other countries, one important way of collaboration is to group participate in international large-scale assessments, such as PISA. Group participation in systematic assessments is necessary for the furthering of the study of socioeconomic effects on mathematics achievement in each country, as well as a global society. Only with additional study and information can the G8 countries implement programs designed to limit the effect of double jeopardy on the mathematics achievement of disadvantaged students. Whether international or national, a systematic assessment, hopefully a longitudinal one, is needed to identify or enact programs at all levels that provide socially disadvantaged students with opportunities to achieve scholastically by lessening the obstacles that these students face on a daily basis. The most effective programs must then be singled out, using a variety of effective assessment strategies, so that they might be provided with the necessary funds and support. This will enable such programs to effectively combat the double jeopardy phenomenon for socially disadvantage students.

Using this approach, the government of each G8 country can then install additional programs, which can help to minimize the double jeopardy effects in the four school locations, associated with the four SES measures. In this manner, each of the G8 countries might be able to balance the advantages enjoyed by higher-SES students and potentially lessen the double jeopardy phenomenon in their respective countries. In addition, because of the limited research into socioeconomic differences defined by double jeopardy, further investigation into the double jeopardy phenomenon should be continued, using other national and international databases. This additional research will create a triangulation, ascertaining both the extent and import of double jeopardy effects on mathematics achievement. Once this is determined, more funding and work can be applied to the assessment and establishment of supportive programs, according to school locations and need.

Specific Implications for Canada. Because all the double jeopardy effects were large in magnitude in Canada, attention to the socioeconomic gap in mathematics achievement must be paid in each of the school locations. However, because double jeopardy is most likely to occur in the city location, as it was the most sensitive of the four school locations to double jeopardy in this study, educators must pay particular attention to the needs in cities. As such, resources (i.e., national and provincial programs) need to be specially allotted to the city location, in order to reduce double jeopardy effects although the rural region, town, and metropolitan locations should not be overlooked.

Based on the sensitivity of the SES measures previously discussed, Canada should utilize the father's SES measure to monitor double jeopardy throughout the country, as it appears to be the best indicator of the dual penalty on mathematics achievement. Specifically, when used to research the socioeconomic effects on mathematics achievement or performance, the father's SES will trigger alarms concerning sensitivity, which can help alert policymakers and educators of the occurrence and development of double jeopardy within different school locations and the country as a whole. Early evidence of this dual penalty will enable policymakers and educators to provide early, and hopefully, successful interventions through national and provincial programs.

It is important to recall that this study not only looked at double jeopardy in the G8 countries, it also examined the double jeopardy effects, after adjusting for student and school characteristics. By utilizing these adjustments, confidence in the above suggestions, based on the magnitude and sensitivity of these results, for policy guidelines and/or change has also increased. Thus, Canada will be better served to consider the above policy implications in addressing the socioeconomic inequity in schooling outcomes.

Specific Implications for Germany. Because the majority of the double jeopardy effects were large in magnitude in Germany, attention to the socioeconomic gap in mathematics achievement must be paid in each of the school locations. This is especially important for Germany, which exhibited the most comprehensive double jeopardy results of all of the G8 countries. However, because double jeopardy is most likely to occur in the metropolitan location, as it was the most sensitive to double jeopardy of the four school locations, educators must pay particular attention to the metropolitan areas. As such, resources (i.e., national and state programs) need to be specially allotted to the metropolitan location, in order to reduce double jeopardy effects; although the rural region, town, and city locations should not be overlooked.

Based on the sensitivity of the SES measures previously discussed, Germany should utilize the combined family SES measure to monitor double jeopardy throughout the country, as it appears to be the best indicator of the dual penalty on mathematics achievement in the country. Specifically, when used to research the socioeconomic effects on mathematics achievement or performance, the combined family SES will trigger alarms for sensitivity, which can help alert policymakers and educators of the occurrence and development of double jeopardy within different school locations and the country as a whole. Early evidence of this dual penalty will enable policymakers and educators to provide early, and hopefully, successful interventions through national and state programs.

This study not only noted double jeopardy in the G8 countries, it also examined the double jeopardy effects after adjusting for student and school characteristics. By utilizing these adjustments, confidence in the above suggestions, based on the magnitude and sensitivity of these results, for policy guidelines and/or change has also increased. Thus, Germany will be better served to consider the above policy implications in addressing the socioeconomic inequity in schooling outcomes.

Specific Implications for Italy. Like Canada and Germany, attention to the socioeconomic gap in mathematics achievement must be paid in each of the school locations for Italy as all of the double jeopardy effects are large in magnitude. However, because double jeopardy is most likely to occur in the town location, as it was the most sensitive to double jeopardy of the four school locations, educators must pay particular attention to towns. As such, resources (i.e., national and state programs) need to be specially allotted to the town location to reduce double jeopardy effects; although the rural region, city, and metropolitan locations should not be overlooked.

Based on the sensitivity of the SES measures previously discussed, Italy should utilize the combined family SES measure to monitor double jeopardy throughout the country, as it appears to be the best indicator of the dual penalty on mathematics achievement in the country. Specifically, when used to research the socioeconomic effects on mathematics achievement or performance, the combined family SES will trigger alarms for sensitivity, which can help alert policymakers and educators of the occurrence and development of double jeopardy within different school locations and the country as a whole. Early evidence of this dual penalty will enable policymakers and educators to provide early, and hopefully, successful interventions through national and state programs.

This study not only looked at double jeopardy in the G8 countries, it also examined the double jeopardy effects, after adjusting for student and school characteristics. By utilizing these adjustments, confidence in the above suggestions, based on the magnitude and sensitivity of these results, for policy guidelines and/or change has also increased. Thus, Italy will be better served to consider the above policy implications in addressing the socioeconomic inequity in schooling outcomes.

Specific Implications for Japan. As previously indicated, double jeopardy in Japan is limited to metropolitan areas. Because of this, and because all of the double jeopardy effects are extremely large in magnitude, policymakers and educators in Japan must pay special attention to the socioeconomic gap in mathematics achievement in the metropolitan school location. In fact, as the only school location exhibiting double jeopardy, educators must focus the majority of their attention on metropolitan areas, the most sensitive school locations to double jeopardy. As such, resources (i.e., national and state programs) need to be specially allotted to the metropolitan location, in order to reduce double jeopardy effects; although the rural region, town, and city locations should not be overlooked. In addition, the remaining three school locations should be examined for factors that might speak to the lack of double jeopardy. If any are identified, policymakers and educators might then be able to implement effective programs or policy changes in metropolitan areas.

Based on the sensitivity of the SES measures previously discussed, Japan should utilize the combined family SES measure to monitor double jeopardy throughout the country, as it appears to be the best indicator of the dual penalty on mathematics achievement in the country. Specifically, when used to research the socioeconomic effects on mathematics achievement or performance, the combined family SES will trigger alarms for sensitivity, which can help alert policymakers and educators to the occurrence and development of double jeopardy within different school locations and the country as a whole. Early evidence of this dual penalty will enable policymakers and educators to provide early, and hopefully, successful interventions through national and state programs.

This study not only looked at double jeopardy in the G8 countries, it also examined the double jeopardy effects, after adjusting for student and school characteristics. By utilizing these adjustments, confidence in the above suggestions, based on the magnitude and sensitivity of these results, for policy guidelines and/or change has also increased. Thus, Japan will be better served to consider the above policy implications in addressing the socioeconomic inequity in schooling outcomes.

Specific Implications for the Russian Federation. Because all of the double jeopardy effects in the Russian Federation are large in magnitude, attention to the socioeconomic gap in mathematics achievement must be paid in the town, city, and metropolitan school locations. However, because double jeopardy is most likely to occur in the metropolitan location, as it was the most sensitive to double jeopardy of the four school locations, educators must pay particular attention to metropolitan areas. As such, resources (i.e., national and state programs) need to be specially allotted to the metropolitan areas in order to reduce double jeopardy effects; although the rural region, town, and city locations should not be overlooked. At the same time, the rural region should be examined for factors that might speak to the lack of double jeopardy. If any are identified, policymakers and educators might then be able to implement additional programs or policy changes in the remaining three school locations.

Based on the sensitivity of the SES measures previously discussed, the Russian Federation should utilize the combined family SES measure to monitor double jeopardy throughout the country, as it appears to be the best indicator of the dual penalty on mathematics achievement in the country. Specifically, when used to research the socioeconomic effects on mathematics achievement or performance, the combined family SES will trigger alarms for sensitivity, which can help alert policymakers and educators to the occurrence and development of double jeopardy within different school locations and the country as a whole. Early evidence of this dual penalty will enable policymakers and educators to provide early, and hopefully, successful interventions through national and state programs.

This study not only looked at double jeopardy in the G8 countries, it also examined the double jeopardy effects, after adjusting for student and school characteristics. By utilizing these adjustments, confidence in the above suggestions, based on the magnitude and sensitivity of these results, for policy guidelines and/or change has also increased. Thus, the Russian Federation will be better served to consider the above policy implications in addressing the socioeconomic inequity in schooling outcomes.

Specific Implications for the United Kingdom. Because the majority of the double jeopardy effects large in magnitude, attention to the socioeconomic gap in mathematics achievement must be paid in all four school locations in the United Kingdom. This is especially important because this country exhibited some of the most widespread double jeopardy results of all the G8 countries. However, because double jeopardy is most likely to occur in the metropolitan location, as it was the most sensitive to double jeopardy of the four school locations, educators must pay particular attention to metropolitan areas. As such, resources (i.e., national and state programs) need to be specially allotted to metropolitan areas, in order to reduce double jeopardy effects; although the rural region, town, and city locations should not be overlooked.

Based on the sensitivity of the SES measures previously discussed, the United Kingdom should utilize the combined family SES measure to monitor double jeopardy throughout the country, as it appears to be the best indicator of the dual penalty on mathematics achievement. Specifically, when used to research the socioeconomic effects on mathematics achievement or performance, the combined family SES will trigger alarms for sensitivity, which can help alert policymakers and educators to the occurrence and development of double jeopardy within different school locations and the country as a whole. Early evidence of this dual penalty will enable policymakers and educators to provide early, and hopefully, successful interventions through national and state programs.

This study not only looked at double jeopardy in the G8 countries, it also examined the double jeopardy effects, after adjusting for student and school characteristics. By utilizing these adjustments, confidence in the above suggestions, based on the magnitude and sensitivity of these results, for policy guidelines and/or change has also increased. Thus, the United Kingdom will be better served to consider the above policy implications in addressing the socioeconomic inequity in schooling outcomes.

Specific Implications for the United States. Because the majority of the double jeopardy effects were large in magnitude, attention to the socioeconomic gap in mathematics achievement must be paid concerning all four school locations in the United States. However, because double jeopardy is most likely to occur in the metropolitan location, as it was the most sensitive to double jeopardy of the four school locations, educators must pay particular attention to metropolitan areas. As such, resources (i.e., national and state programs) need to be specially allotted to metropolitan areas, in order to reduce double jeopardy effects; although the rural region, town, and city locations should not be overlooked.

Based on the sensitivity of the SES measures previously discussed, the United States should utilize the father's SES measure to monitor double jeopardy throughout the country, as it appears to be the best indicator of the dual penalty on mathematics achievement. Specifically, when used to research the socioeconomic effects on mathematics achievement or performance, the father's SES will trigger alarms for sensitivity, which can help alert policymakers and educators to the occurrence and development of double jeopardy within different school locations and the country as a whole. Early evidence of this dual penalty will enable policymakers and educators to provide early, and hopefully, successful interventions through national and state programs.

This study not only looked at double jeopardy in the G8 countries, it also examined the double jeopardy effects, after adjusting for student and school characteristics. By utilizing these adjustments, confidence in the above suggestions, based on the magnitude and sensitivity of these results, for policy guidelines and/or change has also increased. Thus, the United States will be better served to consider the above policy implications in addressing the socioeconomic inequity in schooling outcomes.

Overall Implications. In addition to these recommended changes, this study also highlights the sensitive school locations and SES measures to the global double jeopardy phenomenon. For the majority of the countries, the metropolitan location was the most sensitive to double jeopardy. Similarly, the combined family SES was found to be the most sensitive SES measure. As such, educators and policymakers should be aware of these trends and act accordingly with changes in policy and any programs implemented, primarily focusing on metropolitan areas and the factors influential to the combined family SES.

Limitations and Future Studies

First of all, SES measures are somewhat unconventional in PISA. Conventionally, SES is an integrated measure of parental education, parental occupation, and family income. Because of the difficulty in obtaining family income, PISA used a proxy measure of household items in possession. This replacement, of perhaps the most important SES component, income, with possession may compromise the quality of SES measures. However, because this component is limited to the definition of the combined family SES, it has no bearing on the mother's SES, father's SES, and the family occupation SES, which only utilizes the highest occupation level of the parent. The only portion of this study that might be affected by this substitution is the combined family SES. As the most widespread and sensitive of the SES measures to double jeopardy, the combined family SES could potential over- or under-estimate double jeopardy, based on the use of the number of household possessions rather than family income. If an over-estimation occurred, the results have the potential to be less definite, which might result in changes in the pattern and behavior of double jeopardy in the G8 countries; however, double jeopardy would not likely disappear if family income was utilized instead. In contrast, if an under-estimation occurred, double jeopardy associated with the combined family SES would be even stronger and more compelling in this study, across G8 countries.

This study utilizes the school-effectiveness paradigm, which includes both school-level and student-level factors as control variables. However, these variables were limited to student background characteristics such as gender, immigration background, home language, and family structure, and to contextual and compositional school variables such as school size, school type, proportion of girls, student to mathematics teacher ratio, proportion of mathematics teachers, and proportion of mathematics teachers with a degree in mathematics. Thus, the designated control variables do not address all of the dimensions specified for a complete model of school effectiveness, like process and instructional variables. At the school level, the school-climate variables, such as disciplinary climate, principal leadership, and parental involvement, are important but unavailable in PISA. Although it would be interesting to examine double jeopardy effects, after controlling for both school context and school climate, these variables are also not available in PISA. Furthermore, at the student level, the unavailability of race/ethnicity is a major limitation.

The way that each school location is defined also presents a limitation. Because the classification is very much PISA-specific, it may not be appropriate across all countries. This situation emphasizes each country's need for specific double jeopardy studies, based on the substantive and methodological premises of this study.

A final limitation is the sample size used in this analysis. Although most of the sample sizes are more than adequate for this study, some sample sizes, like those for the metropolitan school location and for Japan's rural school location, were smaller than preferred. More specifically, the sample sizes for the metropolitan locations were the smallest, in terms of both students and schools, with the exception of Japan's rural location. The exact sample size, which is provided in Appendix B, may not be sensitive enough for accuracy in all countries, and all SES measures used may not detect socioeconomic differences among students or among schools in each sample. As such, the sample sizes for these locations might undermine, to some degree, the double jeopardy results.

Future research into the double jeopardy phenomenon should also include more control variables based on the school-effectiveness research paradigm. It is recommended that future research into this topic include both process and instructional variables at the school level so that all dimensions of the school-effectiveness paradigm are addresses. In addition, the race/ethnicity variable should also be included in any future studies because, like SES, it is a powerful predictor of academic achievement. Hence, double jeopardy needs to be examined in the presence of other factors critical to mathematics achievement, as determined by previous research and the research lens utilized for the study. If double jeopardy retains the large effects indicated by this study, over and above the effects of other factors, it bares much stronger policy implications for social and educational reforms.

Another suggestion for further research concerning the double jeopardy phenomenon is based on the diversity of definitions utilized for school location in the literature. More specifically, because of the diverse number of definitions for school location, future research may purposefully examine definitions of regions in different studies and carry out analyses related to double jeopardy for those definitions. This will allow for some comparison of the double jeopardy effects from different studies, and it will enable a better understanding of the phenomenon. In addition, research of this type might also unveil certain characteristics that are more influential to double jeopardy results than others; thus, these studies may identify characteristics essential to minimizing the double jeopardy effects.

The most common definitions for school location are based on rural and urban divisions. The divisions are often described as rural vs. nonrural, rural vs. urban, and rural vs. suburban vs. urban. In some cases, urban areas are considered to be over 100,000 people or as few as 10,000 to 20,000 people. Because of this inconsistency in definition, each country needs to carry out country-specific analyses, based on realistic or strategic definitions of regions.

Future research into the double jeopardy phenomenon should also extend to other countries within the international community. Although this study is not meant to provide a global explanation of double jeopardy, it has showed some similarities between countries in terms of the double jeopardy results. Consequently, extending the study of double jeopardy to countries with greater differences – socially, economically, culturally, and educationally – can help clarify whether double jeopardy is a common effect across cultures and societies; thus, this benefits each country in their quest to improve education and educational attainment for socially disadvantaged students.

Finally, double jeopardy in the mathematics achievement for socially disadvantaged students should also be examined in terms of the students' growth in mathematics. As such, the dual penalty associated with coming from low-SES homes and attending low-SES schools should be analyzed longitudinally, over a time frame of several years. An examination of this design will enable researchers to see if the double jeopardy effect, evident in this study, remains a significant factor in the mathematics achievement of students over time. The results of a longitudinal study will add further insight into the importance of double jeopardy as a contributor to the socioeconomic influence on the academic achievement of students.

Appendix A

Sample Questions from the PISA 2003 Mathematics Assessment

Question 1: Earthquake

A documentary was broadcast about earthquakes and how often earthquakes occur. It included a discussion about the predictability of earthquakes. A geologist stated: "In the next twenty years, the chance that an earthquake will occur in Zed City is two out of three".

Which of the following best reflects the meaning of the geologist's statement?

A 2/3 x 20 = 13.3, so between 13 and 14 years from now there will be an earthquake in Zed City.

B 2/3 is more than ½, so you can be sure there will be an earthquake in Zed City at some time during the next 20 years.

C The likelihood that there will be an earthquake in Zed City at some time during the next 20 years is higher than the likelihood of no earthquake.

D You cannot tell what will happen, because nobody can be sure when an earthquake will occur.

Question 2: Support for the President

In Zedland, opinion polls were conducted to find out the level of support for the President in the forthcoming election. Four newspaper publishers did separate nationwide polls. The results for the four newspaper polls are shown below.

Newspaper 1: 36.5% (poll conducted on January 6, with a sample of 500 randomly selected citizens with voting rights)

Newspaper 2: 41.0% (poll conducted on January 20, with a sample of 500 randomly selected citizens with voting rights)

Newspaper 3: 39.0% (poll conducted on January 20, with a sample of 1000 randomly selected citizens with voting rights)

Newspaper 4: 44.5% (poll conducted on January 20, with 1000 readers phoning into vote).

Which newspaper's result is likely to be the best for predicting the level of support for the President if the election is held on January 25? Give two reasons to support your answer.

Question 3: Space Flight

Space station Mir remained in orbit for 15 years and circled Earth some 86,500 times during its time in space. The longest stay of one cosmonaut in the Mir was around 680 days. The Mir circled Earth at a height of approximately 400 kilometers. The diameter of the Earth is about 12,700 km and its circumference is about 40,000 km

$(\pi \times 12700)$.

Give an estimate of the total distance the Mir travelled during its 86,500 revolutions while in orbit. Round your answer to the nearest 10 million.

Question 4: Exchange Rate

Mei-Ling from Singapore was preparing to go to South Africa for 3 months as an exchange student. She needed to change some Singapore dollars (SGD) into South African rand (ZAR).

1. Mei-Ling found out that the exchange rate between Singapore dollars and South African Rand was: 1 SGD = 4.2 ZAR. Mei-Ling changed 3000 Singapore dollars into South African rand at this exchange rate. How much money in South African rand did Mei-Ling get?

2. On returning to Singapore after 3 months, Mei-Ling had 3900 ZAR left. She changed this back to Singapore dollars, noting that the exchange rate had changed to: 1 SGD = 4.0 ZAR. How much money in Singapore dollars did Mei-Ling get?

3. During these 3 months the exchange rate had changed from 4.2 to 4.0 ZAR per SGD. Was it in Mei-Ling's favor that the exchange rate now was 4.0 ZAR instead of 4.2 ZAR, when she changed her South African rand back into Singapore dollars? Give an explanation to support your answer.

Note: Sample questions from PISA 2003 Mathematics Assessment came directly from the test questions on the PISA website at the following address: http://www.pisa.oecd.org/document/38/0,3343,en_32252351_32236173_34993126_1_1_1_1,00.html

Appendix B

Sample Sizes for the G8 Countries

	Rural Region	Town	City	Metropolitan	Total
Canada					
Student	6644	2530	2877	850	12901
School	249	91	114	36	490
Germany					
Student	1041	1136	565	392	3134
School	45	50	25	17	137
Italy					
Student	1846	5338	2320	265	9769
School	67	177	76	10	330
Japan					
Student	223	1372	2201	724	4520
School	7	42	67	22	138
Russian Federation					
Student	1416	1129	1306	1033	4884
School	66	36	40	32	174
United Kingdom					
Student	2503	2399	1885	372	7159
School	99	94	78	16	287
United States					
Student	1238	1128	624	165	3155
School	58	56	32	9	155

Note. France is excluded from the study resulting from data missing at the school level.

Appendix C

Percentage of the School Locations in the G8 Countries

	Rural Region	Town	City	Metropolitan
Canada	51%	19%	23%	7%
Germany	33%	37%	18%	12%
Italy	20%	54%	23%	3%
Japan	5%	30%	49%	16%
Russian Federation	38%	21%	23%	18%
United Kingdom	35%	33%	27%	6%
United States	37%	36%	21%	6%

Note. The percentages are approximations based on the rounding up or down of the calculated proportions of the number of schools in each school location to the total school sample size.

Appendix D

School-Level Control Variables for each Double Jeopardy Model

	Rural Region	Town	City	Metropolitan
Canada				
Father's SES	Schlsize*	Schlsize*	Schlsize* Pcgirls* Smratio*	Propmath*
Mother's SES	Schlsize* Schltype*	Schlsize*	Schlsize*	Pcgirls*
Family Occupation SES	Schlsize* Schltype*	Schlsize* Pcgirls*	Schlsize* Pcgirls*	Propmath*
Combined Family SES	Schlsize* Schltype*	Schlsize* Pcgirls*	Schlsize*	Propmath*
Germany				
Father's SES	Pcgirls* Propmath*	Pcgirls*	Propmathdeg*	Smratio* Propmathdeg*
Mother's SES	Schlsize* Pcgirls*	Pcgirls*	Propmath* Propmathdeg*	Smratio*
Family Occupation SES	Pcgirls* Smratio*	Pcgirls* Propmath*	Propmath* Propmathdeg*	Smratio*
Combined Family SES	Pcgirls*	Pcgirls* Propmath*	Propmath* Propmathdeg*	Smratio*

Italy				
Father's SES	Schlsize	Propmath	Propmath*	Propmathdeg*
Mother's SES	Pcgirls* Propmathdeg*	Propmath*	Propmath*	Propmathdeg*
Family Occupation SES	Schltype*	Propmathdeg	Propmath*	Propmathdeg*
Combined Family SES	Schltype	Propmath	Propmath*	Propmathdeg*
Japan				
Father's SES	Schlsize*	Schltype* Propmath*	Smratio*	Schltype*
Mother's SES	Schlsize	Schltype*	Schltype	Schltype*
Family Occupation SES	Schlsize	Schltype* Propmath*	Schltype*	Schltype*
Combined Family SES	Schlsize	Schltype*	Schltype*	Schltype* Smratio*
Russian Federation				
Father's SES	Smratio	Smratio*	Propmath*	Pcgirls
Mother's SES	Smratio	Smratio*	Propmath	Pcgirls
Family Occupation SES	Smratio	Schlsize* Smratio*	Propmath	Pcgirls
Combined Family SES	Smratio*	Smratio*	Propmath*	Propmathdeg

United Kingdom				
Father's SES	Propmathdeg	Pcgirls*	Propmathdeg	Propmathdeg*
Mother's SES	Propmathdeg	Pcgirls	Pcgirls* Propmathdeg*	Propmathdeg*
Family Occupation SES	Propmathdeg	Pcgirls	Propmath*	Propmath
Combined Family SES	Propmathdeg	Pcgirls*	Propmath*	Propmath*
United States				
Father's SES	Schltype*	Schlsize* Propmathdeg*	Schltype* Propmathdeg*	Schlsize*
Mother's SES	Schltype*	Schlsize* Pcgirls*	Schlsize*	Propmath*
Family Occupation SES	Schltype*	Schlsize* Propmathdeg*	Propmath*	Propmath*
Combined Family SES	Schltype*	Pcgirls*	Schlsize	Propmath*

* $p < 0.05$.

Note. Japan also excluded variables at the student level as a result of low frequency relating to native students and foreign language spoken at home. The rural region excluded both variables, while the town, city, and metropolitan areas only excluded the immigration variable describing native and non-native students. In addition, the variable for single parent families was not provided by Japan in the PISA data so could not be included.

Appendix E

Descriptive Statistics for Canada

	Mean	SD
Mathematics Achievement	532.00	87.00
Student-Level Variables		
Father's Socioeconomic Status (SES)	43.35	16.71
Mother's SES	46.06	15.82
Family Occupation SES	50.75	15.97
Combined Family SES	0.35	0.85
Male [vs. Female]	0.50	0.50
Native Born [vs. Non-native Born]	0.95	0.23
Foreign Language Spoken [vs. Native Language]	0.06	0.25
Single-Parent Family [vs. Other Family Structures]	0.19	0.39
School-Level Variables		
Mean Father's SES	42.96	8.06
Mean Mother's SES	45.65	6.41
Mean Family Occupation SES	50.26	7.32
Mean Combined Family SES	0.32	0.43
School Size	677.58	472.00
Proportion of Girls	0.49	0.07
School Type	2.88	0.45
Student to Mathematics Teacher Ratio	112.49	67.97
Proportion of Mathematics Teachers	0.21	0.14
Proportion of Mathematics Teachers with a Degree in Mathematics	0.64	0.31

Appendix F

Descriptive Statistics for Germany

	Mean	SD
Mathematics Achievement	503.00	103.00
Student-Level Variables		
Father's Socioeconomic Status (SES)	45.51	17.09
Mother's SES	43.60	15.37
Family Occupation SES	49.60	16.26
Combined Family SES	0.18	0.99
Male [vs. Female]	0.50	0.50
Native Born [vs. Non-native Born]	0.92	0.27
Foreign Language Spoken [vs. Native Language]	0.07	0.26
Single-Parent Family [vs. Other Family Structures]	0.17	0.37
School-Level Variables		
Mean Father's SES	44.66	8.38
Mean Mother's SES	42.69	7.09
Mean Family Occupation SES	48.83	8.44
Mean Combined Family SES	0.14	0.58
School Size	658.58	326.46
Proportion of Girls	0.52	0.12
School Type	2.91	0.32
Student to Mathematics Teacher Ratio	74.16	43.44
Proportion of Mathematics Teachers	0.28	0.12
Proportion of Mathematics Teachers with a Degree in Mathematics	0.87	0.20

Appendix G

Descriptive Statistics for Italy

	Mean	SD
Mathematics Achievement	466.00	96.00
Student-Level Variables		
Father's Socioeconomic Status (SES)	43.34	15.97
Mother's SES	43.14	17.11
Family Occupation SES	47.54	16.29
Combined Family SES	-0.02	0.97
Male [vs. Female]	0.48	0.50
Native Born [vs. Non-native Born]	0.98	0.14
Foreign Language Spoken [vs. Native Language]	0.02	0.13
Single-Parent Family [vs. Other Family Structures]	0.15	0.36
School-Level Variables		
Mean Father's SES	42.75	7.65
Mean Mother's SES	41.94	8.49
Mean Family Occupation SES	46.59	8.32
Mean Combined Family SES	-0.09	0.58
School Size	611.72	345.22
Proportion of Girls	0.49	0.27
School Type	2.94	0.32
Student to Mathematics Teacher Ratio	83.44	32.08
Proportion of Mathematics Teachers	0.12	0.10
Proportion of Mathematics Teachers with a Degree in Mathematics	0.72	0.27

Appendix H

Descriptive Statistics for Japan

	Mean	SD
Mathematics Achievement	534.00	101.00
Student-Level Variables		
Father's Socioeconomic Status (SES)	44.73	14.08
Mother's SES	46.39	14.90
Family Occupation SES	49.84	14.74
Combined Family SES	-0.09	0.73
Male [vs. Female]	0.49	0.50
Native Born [vs. Non-native Born]	1.00	0.03
Foreign Language Spoken [vs. Native Language]	0.00	0.05
Single-Parent Family [vs. Other Family Structures]	-	-
School-Level Variables		
Mean Father's SES	44.21	6.17
Mean Mother's SES	46.27	5.20
Mean Family Occupation SES	49.55	5.73
Mean Combined Family SES	-0.10	0.41
School Size	847.35	399.60
Proportion of Girls	0.51	0.23
School Type	2.50	0.87
Student to Mathematics Teacher Ratio	127.89	53.47
Proportion of Mathematics Teachers	0.13	0.11
Proportion of Mathematics Teachers with a Degree in Mathematics	-	-

Note. Data on family structure and the proportion of mathematics teachers with a degree in Mathematics is missing.

Appendix I

Descriptive Statistics for the Russian Federation

	Mean	SD
Mathematics Achievement	468.00	92.00
Student-Level Variables		
Father's Socioeconomic Status (SES)	42.51	16.02
Mother's SES	46.46	16.79
Family Occupation SES	50.22	16.02
Combined Family SES	-0.06	0.75
Male [vs. Female]	0.48	0.50
Native Born [vs. Non-native Born]	0.93	0.26
Foreign Language Spoken [vs. Native Language]	0.05	0.22
Single-Parent Family [vs. Other Family Structures]	0.22	0.41
School-Level Variables		
Mean Father's SES	41.44	6.99
Mean Mother's SES	45.84	6.25
Mean Family Occupation SES	49.43	6.73
Mean Combined Family SES	-0.13	0.41
School Size	675.63	421.97
Proportion of Girls	0.48	0.11
School Type	2.99	0.15
Student to Mathematics Teacher Ratio	146.05	95.45
Proportion of Mathematics Teachers	0.12	0.08
Proportion of Mathematics Teachers with a Degree in Mathematics	0.88	0.19

Appendix J

Descriptive Statistics for the United Kingdom

	Mean	SD
Mathematics Achievement	*	*
Student-Level Variables		
Father's Socioeconomic Status (SES)	44.12	17.37
Mother's SES	42.53	16.48
Family Occupation SES	49.54	16.56
Combined Family SES	0.09	0.90
Male [vs. Female]	0.49	0.50
Native Born [vs. Non-native Born]	0.97	0.17
Foreign Language Spoken [vs. Native Language]	0.02	0.15
Single-Parent Family [vs. Other Family Structures]	0.21	0.41
School-Level Variables		
Mean Father's SES	43.44	7.43
Mean Mother's SES	41.89	6.45
Mean Family Occupation SES	48.98	7.19
Mean Combined Family SES	0.06	0.45
School Size	969.94	366.00
Proportion of Girls	0.50	0.19
School Type	2.92	0.39
Student to Mathematics Teacher Ratio	129.90	28.63
Proportion of Mathematics Teachers	0.12	0.06
Proportion of Mathematics Teachers with a Degree in Mathematics	0.79	0.24

Note. The mean achievement on the PISA 2003 mathematics assessment was listed differently from other countries. The mean performance and standard deviation on the mathematics scale was provided according to quarters of the index of the quality of the schools' educational resources. The resulting data for the four quarters are as follows: 499.00 (190.00), 497.00 (145.00), 502.00 (148.00), and 531.00 (145.00).

Appendix K

Descriptive Statistics for the United States

	Mean	SD
Mathematics Achievement	483.00	95.00
Student-Level Variables		
Father's Socioeconomic Status (SES)	46.46	18.58
Mother's SES	49.22	15.44
Family Occupation SES	54.19	16.38
Combined Family SES	0.28	0.90
Male [vs. Female]	0.50	0.50
Native Born [vs. Non-native Born]	0.94	0.24
Foreign Language Spoken [vs. Native Language]	0.09	0.29
Single-Parent Family [vs. Other Family Structures]	0.31	0.46
School-Level Variables		
Mean Father's SES	45.83	8.09
Mean Mother's SES	48.83	5.69
Mean Family Occupation SES	53.79	6.85
Mean Combined Family SES	0.25	0.48
School Size	1289.63	882.79
Proportion of Girls	0.50	0.10
School Type	2.87	0.49
Student to Mathematics Teacher Ratio	124.79	39.85
Proportion of Mathematics Teachers	0.14	0.08
Proportion of Mathematics Teachers with a Degree in Mathematics	0.84	0.22

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